Access to Microfinance & Improved Implementation of Policy Reform
(AMIR Program)

Funded By U.S. Agency for International Development
(USAID)

AQABA INTERNATIONAL INDUSTRIAL ESTATE
FEASIBILITY STUDY

ENVIRONMENTAL ASSESSMENT

Final Report

Deliverable for IIPR Components, Task No. 4.1.25.3
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List of Abbreviations

AD	Anno Domini
AIIE	Aqaba International Industrial Estate
AMIR	Access to Microfinance and Improved Implementation of Policy Reform Project
APC	Aqaba Port Corporation
ARA	Aqaba Region Authority
AMWWTP	Aqaba Municipal Wastewater Treatment Plant
BC	Before Christ
BGL	Below Ground Level
BOD	Biochemical Oxygen Demand
CDG	Community Development Group
du	Dunum (1000 m^2)
ECO	EnviroConsult Office
EA	Environmental Assessment
FSEZ	Free Port and Special Economic Zone
GCEP	General Corporation for Environmental Protection
JADIS	Jordanian Antiquities Database Information System
JD	Jordanian Dinar
JICA	Jordanian International Corporation Agency
JIEC	Jordan Industrial Estates Corporation
JVA	Jordan Valley Authority
masl	Meters Above Sea Level
m^3	Cubic Meters
m^3/d	Cubic Meters per Day
MCM	Million Cubic Meters
MWI	Ministry of Water and Irrigation
NGO	Non-Governmental Organization
QIZ	Qualified Industrial Zone
SEZ	Special Economic Zone
TSG	The Services Group
TSP	Total Solid Particulates
TSS	Total Suspended Solids
USAID	United States Agency for International Development
WAJ	Water Authority of Jordan
WWTP	Wastewater Treatment Plant

1. Executive Summary

1.1 Introduction

Through the Access to Microfinance and Improved Implementation of Policy Reform Project (AMIR), USAID has retained The Services Group (TSG), EnviroConsult Office (ECO), and the Community Development Group (CDG) / Al-Jidara to conduct a feasibility study, physical master plan design, and Environmental Assessment (EA) for a proposed Aqaba International Industrial Estate (AIIE). Suitable land has been identified in Aqaba, and a preliminary study indicates that the property may be suitable for the development of a light industrial estate, possibly with Qualified Industrial Zone (QIZ) status.

This Environmental Assessment document will assess the impacts of the establishment of the first phase of the project, culminating in the development of 130 hectares of the Proposed Estate. This document will not assess the siting options in detail, since this has been performed in previous studies. Nevertheless, an overview of the reasons that the selected site was chosen over other site alternatives will be presented.

The EA focuses on the construction stage of the Proposed Action and covers environmental issues related to its operation in more general terms. The exact types of industries will only become known when investors apply for establishment within the AIIE. Therefore, the operational issues that are discussed are those that are expected to be in common among investor operations and those that are related to the estate's administration.

Since the project is being funded by the United States Agency for International Development (USAID), the EA is being conducted under the applicable USAID regulations (Handbook 3, Appendix 2D, Part 216) for USAID funded projects under a host country contract. These procedures are consistent with the purposes of the US National Environmental Policy Act of 1970, the draft Jordanian EIA by-law and with the Aqaba Regional Authority's Environmental Assessment Operational Directives. Accordingly a Scoping Session and consultations have been conducted with several stakeholders and interested parties.

1.2 Content

The EA has been prepared to fulfil the applicable USAID regulations according to the following content (described in more detail in Section 2.5):

Chapter 1. *Executive Summary*
Chapter 2. *Introduction and Purpose*
Chapter 3. *Alternatives including the Proposed Action*
Chapter 4. *Affected Environment*
Chapter 5. *Environmental Consequences*
Chapter 6. *Recommended Mitigation Measures & Environmental Monitoring*
Chapter 7. *List of Preparers*
Chapter 8. *Annexes*

1.3 Issues Scoping

Parties having expertise and knowledge relevant to the project were asked to comment on the potential environmental issues that require analysis during preparation of the EA. Participants provided comments on potential socio-economic, atmospheric and natural issues, which collectively represent the scope of environmental concerns, related to the project. Results of the Scoping Sessions are detailed in the Scoping Statement document issued and approved according to USAID regulations.

Scoping was conducted on an individual basis in Amman and in Aqaba in addition to a formal Scoping Session held in Aqaba on the 13th of March 2000. A list of the persons met and who have participated in the Scoping Session are presented in Annex A. A summary of the results of Scoping, significant and non-significant environmental issues are presented below.

Significant Environmental Issues

- Wastewater
- Solid Wastes
- Employment & Economy
- Health and Safety
- Dust
- Emissions
- Water Consumption
- Aesthetics
- Soil Disturbance
- Groundwater
- Archaeology

Non-significant Environmental Issues

- Flood Water
- Noise
- Traffic Disruptions
- Seismic Risks
- Marine Ecology and Coral Reefs
- Flora, Fauna, and Habitats

1.4 Proposed Action

A demand study produced a number of investment scenarios based on demands for industrial space in Aqaba. The most feasible demand scenario included a combination of industries as part of a QIZ (light and medium manufacturing, and warehouses for distribution) and local demand generated by current industries in Aqaba moving into the Proposed Estate (light and medium manufacturing).

The Proposed Action is a combination of preferred alternatives of various selected industrial estate components. The preferred alternatives for these components that make up the Proposed Action are briefly discussed below.

Selected Site, Location and Development Phases

The selected site location has been studied previously during the 1997 JICA "Study on Development in the Southern Districts of Jordan" and was concurred during the 1999 TSG study on "Accelerating Private Investment in the Aqaba Region: Strategic Options for USAID". The southern half of the 277ha site has been selected over the northern portion for the three phases (130ha) of development: Phase I (0-5 years) 30ha; Phase II (5-10 years) 23ha; Phase III (10-20 years) 77ha.

Roads and Site Entrance

The main entrance to the site is perpendicular to the existing and Proposed New Airport Highway. The main road network inside the Proposed Estate will follow an East-West axis, intersected by sub main roads running in a North-South direction. USAID has proposed to fund the construction of part of the Proposed New Airport Highway up to the site's main entrance. This highway will be expanded in the future as a full substitute for the existing Dead Sea Road airport section. Off-site utility connections will be aligned with this proposed new highway.

Wastewater and Surface Water Run-off

Wastewater generated within the Estate is expected to result from sanitation and domestic-type usage; non-domestic-type wastewater will not be collected in the sanitary system, but should be treated on site to allow for discharge to the sanitary system. The wastewater will be conveyed by a 2,600m^3/day capacity pipeline (sufficient up to 20 years: all three Phases) to the Aqaba Municipal Wastewater Treatment Plant (AMWWTP) located approximately 4km SSW of the selected site. Surface run-off flowing from the mountains to the east requires drainage ditches to protect the Proposed Estate from infrequent, but potentially damaging flash floods.

Water

In general, 20m^3/ha/day is assumed as a standard unit (area) water demand for the Estate. This water demand will be met from the Aqaba Water Authority. A 2,600m^3/day capacity pipeline will need to be constructed to supply this water from 4km south of the site that would be aligned with the Proposed New Airport Highway. In addition, sub-surface and elevated reservoirs will be constructed for each Development Phase along with an associated distribution and pumping system. For landscaping and irrigation requirements in the AIIE, treated wastewater will be pumped from the open storage reservoir proposed approximately 200m south of the Estate.

Built Up and Serviced Areas

The Proposed Action opts for developing 75% of the 130ha site as individual plots for investor use while the remaining 25% will be common land. Common land includes roads, services and bare areas. Of the 75% Plots Areas Ratio, a 60% Under-roof Space to Plot Area Ratio has also been adopted in accordance with the maximum limit set by the Jordanian Industrial Estates Corporation (JIEC).

Buildings

Under the Proposed Action, 5% of Phase I, including ancillary buildings will be developed for immediate use by investors as a kick-start for the Proposed Estate. A combined steel and concrete frame was chosen for the pre-built factory units. Ancillary buildings will be constructed on the smallest area possible and will include a fire station, medical facility, mosque and commercial services/management center.

Landscaping

Landscaping will involve planting of a green belt around the perimeter of the entire Estate for wind protection and aesthetics in addition to trees and shrubs planted along internal roads.

Electricity and Telecommunications

A primary power substation would need to be built on site that will be connected via overhead transmission lines to a substation in Aqaba (operated by the Aqaba Electrical Distribution Company) approximately 4km south of the Estate. The Jordanian Telecommunications Company will satisfy telecommunication demands through subsurface fiber-optic cables. These utility lines will also run along the Proposed New Airport Highway.

1.5 Feasible Alternatives

Other feasible alternatives are closely related to the Proposed Action. The main differences between the Proposed Action and other feasible alternatives lie in the design options of separate Proposed Estate components as briefly described above. The result is different environmental consequences as related to different alternatives including the developed portion of the site, wastewater, water supply, access roads, built-up and serviced area ratios and development phasing. These alternatives to the Proposed Action are described in detail and compared in Chapter 3.

1.6 Affected Environment

The Environmental Assessment team performed a biological reconnaissance survey and an archaeological survey of the study area. The Department of Antiquities / Aqaba performed a 2-day survey of the project area to ensure that no significant archaeological artifacts or sites are present at the selected site or along potential access routes. Other baseline data was obtained from various reports (Annex F) and previous assessments.

The affected environment includes the physical, biological and socio-economic environments. The environmental components described in the report under these main headings are the following:

Physical Environment & Infrastructure

- Climate
- Topography and Landscape
- Soil, Geology and Seismicity
- Air Quality
- Water Resources
- Solid Waste
- Wastewater

Socio-economic Environment

- Population
- Employment and Industry
- Land Use and Development Plans
- Tourism
- Aesthetics
- Archaeology

Biological Environment

- Marine Environment
- Flora, Fauna, and Habitats

1.7 Impacts of the Proposed Action

In general, assuming that clear and comprehensive environmental monitoring, permitting and operating procedures are developed and that recommended mitigation measures implemented

as described in detail in Chapter 6, the Proposed Action is not expected to result in any significant adverse environmental impacts. Significant positive impacts, however are expected in relation to employment and economy. In addition, if the Proposed Estate is realized with additional concern for aesthetics during the design and since it is the first major development in the area (other than the airport), the indirect benefits related to the physical and economic development of the area will be enhanced.

The negative impacts expected to result from the Proposed Action are similar to any construction project if not less significant due to the environmental attributes of the selected site. The negative impacts expected during operation are very dependent on the types of industries permitted to establish.

For more details on the impacts of the Proposed Action, refer to Chapter 5. The Proposed Action is also compared with other feasible alternatives as well as the No-Action Alternative (summarized in Table 3.3). The results of this comparison revealed that the Proposed Action is the most preferable option from an environmental point of view.

1.8 Recommendations

Environmental permitting and operating procedures should be well developed to ensure that the operation of the Proposed Estate is environmentally sound. Of particular sensitivity are issues related to air pollution, solid waste generation, occupational health, water consumption, wastewater generation and aesthetics. An environmental monitoring program should also be developed for these issues depending on the types of industries that are permitted to operate in the Proposed Estate. These guidelines and procedures should clearly state the parties (i.e. ASEZ Authority, Estate Operator, Investors, etc.) that are responsible for their implementation, enforcement, measurements, and reporting.

In addition to the development of permitting, operating and monitoring, a contingency plan should also be developed and the mitigation measures set out in Chapter 5 and 6 should be implemented. The plan would serve as a guide for appropriate action in the event of accidents, spills and breaches of standards set out in the operating procedures and monitoring plan.

A separate environmental assessment is required for the design and construction of the Proposed New Airport Highway as proposed by USAID (refer to Section 3.3). The consequences of constructing and operating this proposed highway are not assessed in this document as it is considered as a separate project.

This Environmental Assessment for Aqaba International Industrial Estate is conducted based only the premise of the potential industries identified in the marketing studies carried out in the feasibility study. These are light industries that have minimal environmental impact during operation, and mitigation measures are designed to address all foreseen impacts of these particular industries. However, any alterations to the composition of these industries might create synergetic impacts that are not studied here and this will warrant another environmental impact assessment study to be conducted for Aqaba Industrial Estate

Table of Contents

List of Tables

List of Figures

2. Introduction

2.1 Background

Through the Access to Microfinance and Improved Implementation of Policy Reform Project (AMIR), USAID is supporting Jordan's ongoing economic reform process, including specific efforts at attracting foreign investment. USAID is interested in fostering the development of a privately developed and serviced industrial property in Aqaba as a mechanism to increase private sector-led investment and economic growth. Suitable land has been identified in Aqaba, and a preliminary study indicates that the property may be suitable for the development of a light industrial estate, possibly with Qualified Industrial Zone (QIZ) status.

USAID has retained The Services Group (TSG), EnviroConsult Office (ECO), and the Community Development Group (CDG) / Al-Jidara to conduct a feasibility study, physical master plan design, and Environmental Assessment (EA) of the proposed Industrial Estate.

This Environmental Assessment document will assess the impacts of the establishment of the first phase of the project, culminating in the development of 50 hectares of the Proposed Estate.

This document will not assess the siting options in detail, since this has been performed in "Study on Industrial Development in the Southern Districts of the Hashemite Kingdom of Jordan". Nevertheless, an overview of the reasons that the selected site was chosen over other site alternatives will be presented.

Scoping Sessions have been conducted with several stakeholders and interested parties (Scoping Participants are listed in Annex A) where environmental issues were screened according to their significance.

2.2 Project Setting

The selected site is located north of the town of Aqaba, east of Aqaba International Airport and is bordered by the proposed New Aqaba Dead Sea Highway from the east and the proposed Safi Road to the west. The site is approximately 4 km north east of the Aqaba Municipal Wastewater Treatment Plant (AMWWTP) and just north of the proposed open storage reservoirs for treated wastewater effluent from the plant.

2.3 Need for the Project and Purpose

There is an inherent need in attracting foreign investment into the country for continued economic and social development. Nevertheless, one of the main deterrents to foreign investments in Jordan and specifically in the southern Governorates is the lack of attractive land that is sufficient in area and services. Moreover, developed industrial estates are controlled by the government through parastatal entities while private sector developments remain low.

Many industries that are currently located in Aqaba proper and outskirts geared toward servicing the transportation sector in Aqaba negatively affect the aesthetics of the town and its environmental resources. The establishment of a light industrial estate would offer a discreet and properly serviced location for existing and future industries and services.

Some of the direct objectives of the proposed project are the following:

- Provide well-serviced commercial and industrial land for local and international investors in Jordan;
- Develop a well-developed and modern estate in Jordan that is attractive in size and quality for international investments;
- Reduce the industrial development disparity between the northern and southern regions of Jordan; and
- Make use of Aqaba's strategic regional location, well developed infrastructure and congregated transportation facilities that include the airport and seaports.

The demand for land for light manufacturing in Aqaba ranges between 150 ha (conservative estimates) and 240 ha (according to historical growth patterns) over the next 20 years, depending on the regime adopted. The most likely demand scenario for the AIIE is that it will service projected demand for light Qualified Industrial Zone (QIZ) industrial space in the apparel, electronics, footwear and other sectors.

2.4 Applicable Environmental Assessment Regulations

In Jordan two institutions have been involved in the design of environmental assessment regulations: these are the General Corporation for Environmental Protection (GCEP) and the Aqaba Region Authority (ARA). GCEP has prepared an Environmental Impact Assessment By-law that specifies the need for an Environmental Impact Assessment to be conducted for selected projects in Jordan, and the administrative mechanism for doing so. The ARA has designed EIA Operational Directives, modified from the World Bank Operational Directive 4.01 that specify the need for Environmental Assessments to be prepared for certain projects in the Aqaba Governorate.

It is not yet clear which of the two regulations will be applied in Aqaba since the jurisdictions of the two institutions overlap. Furthermore, neither of the prepared regulations has been approved by the Jordanian Government, therefore, their content may be further adapted.

Since the project is being funded by USAID, the EA is being conducted under the applicable USAID regulations (Handbook 3, Appendix 2D, Part 216) for USAID funded projects under a host country contract. These procedures are consistent with the purposes of the US National Environmental Policy Act of 1970, the draft Jordanian (GCEP) EIA by-law and with the ARA's Operational Directives.

2.5 EA Objectives and Methodology

This Environmental Assessment (EA) has been carried out according to USAID regulations (Handbook 3, Appendix 2D Part 216) for USAID funded projects under a host

country contract. Scoping has been conducted in Amman (meetings) and Aqaba (meeting and scoping session) where interested and affected parties (stakeholders) expressed their views regarding the potential environmental consequences of undertaking the proposed project and where issues that would require analysis during preparation of the EA were identified. Following the Scoping Session and meetings and based on their results a Scoping Statement that identified significant environmental issues on which this EA report will focus was prepared. The Scoping Statement was distributed to stakeholders for review and has been approved by USAID. Issues that were regarded as non-significant will not be addressed in detail.

In general, the objectives of this Environmental Assessment (EA) are the following:

- To assess the Proposed Action, other feasible alternatives, and the No-Action Alternative based on the significant issues identified in the Scoping;
- To identify predictable positive and negative environmental impacts of the Proposed Action and feasible alternatives allowing for an evaluation of their relative significance;
- To recommend mitigation measures that minimize negative impacts and enhance positive interventions during the construction and operation stages of the Proposed Action; and
- To provide recommendations to be considered during subsequent preparation of an environmental management and monitoring plan.

Information on the environmental attributes, infrastructure, planning guidelines, transportation links, and utilities of the study area have been well-documented through various reports including the 1997 JICA Study and the 1999 Aqaba Freeport Feasibility Study and Implementation Plan among others. For the EA, environmental data were collected from various reports and statistics in addition to reconnaissance surveys assessing archaeology and bio-diversity.

Data on water resources, including groundwater, surface water flows and water supplies were collected from the Ministry of Water and Irrigation as well as from other various reports addressing these issues. Data regarding water requirements, wastewater quantities and qualities, and economic benefits were taken from the feasibility study performed in parallel with the EA. Data concerning flora, fauna, their habitats and status were provided from relevant specialists.

An archaeological survey was conducted and the JADIS database consulted. The Department of Antiquities in Aqaba performed the archaeological survey. In addition, the Environmental Assessment Team performed a reconnaissance survey of the study area to determine further survey requirements and to verify some available desktop data.

Various alternatives were assessed with the co-operation of relevant authorities and interested parties as well as with the design and feasibility study teams. In general, a subjective approach that utilizes the professional judgment and opinions of experts formed the majority of the assessment and analyses required.

The EA has been prepared to fulfill the applicable USAID regulations' requirements with the following content and format:

Chapter 1. *Executive Summary*
Major conclusions, areas of controversy (if any), and issues still to be resolved.

Chapter 2. *Introduction and Purpose*
Underlying purpose and need to which the Proposed Action and alternatives are responding to.

Chapter 3. *Alternatives including the Proposed Action*
The environmental impacts of the Proposed Action and alternatives, including the No-Action Alternative are presented in detail and comparative form. Reasonable alternatives are briefly explored and reasons for their exclusion from the detailed assessment provided.

Chapter 4. *Affected Environment*
Describes the environment(s) to be affected by the alternatives under consideration in order to provide the basis for understanding the effects of the alternatives. Any effects that the environment may have on the Proposed Action are also identified.

Chapter 5. *Environmental Consequences*
This section forms the analytical basis for the comparison made under Section 3. Impacts of the Proposed Action and its alternatives are discussed including: any adverse effects that are unavoidable; the relationship between long-term and short-term effects; direct effects and their significance; indirect effects and their significance; the temporal and spatial extents of impacts; possible conflicts between the Proposed Action and any other land-use plans, policies or controls over the area; energy and water requirements; the conservation potential of various alternatives and mitigation measures; socio-economic impacts; and means to mitigate any adverse environmental impacts.

Chapter 6. *Recommended Mitigation Measures & Environmental Monitoring*

This section identifies the areas where additional monitoring work is required to measure changes in the environmental quality resulting from implementation of the Proposed Action and lists the recommended mitigation measures.

Chapter 7. *List of Preparers*
A list of the names and qualifications of the persons responsible for the preparation of the EA.

Chapter 8. *Annexes*
The annexes contain detailed data, other material and references used in the assessment.

2.6 Scoping Session and Consultations

In accordance with applicable USAID regulations a Scoping Session and individual consultations were conducted, where parties having expertise and knowledge relevant to the project were asked to comment on the potential environmental issues that require

analysis during preparation of the Environmental Assessment. Participants provided comments on potential socio-economic, atmospheric and natural issues, which collectively represent the scope of environmental concerns, related to the project. Results of the Scoping Sessions are detailed in the Scoping Statement document issued according to USAID regulations.

Scoping was conducted on an individual basis in Amman and in Aqaba in addition to a Scoping Session held in Aqaba on the 13th of March 2000. A list of the persons met and who have participated in a Scoping Sessions are presented in Annex A. A summary of the results of Scoping, a relative significance rating for identified environmental issues are presented in Table 2.1 at the end of this chapter.

Table 2.1: Significance of Environmental Issues

Environmental Issues	Significance Score**	
	Construction	Operation
Wastewater (Disposal of Wastes)*	3	4
Solid Wastes (Disposal of Wastes)*	3	4
Employment & Economy	2	4
Health and Safety	2	4
Dust	4	2
Emissions	2	4
Water Consumption (Water Resources)*	1	4
Aesthetics	2	3
Soil Disturbance	2	3
Groundwater (Water Resources)*	2	3
Flood Water (Water Resources)*	1	3
Archaeology	4	1
Noise*	2	2
Traffic Disruptions	1	2
Earthquake Risks*	1	2
Marine Ecology and Coral Reefs	1	2
Fauna, Flora and Habitats	2	1

* *Indicates refinement to the preliminary environmental issues during scoping.*

** *Information on how scores for the environmental issue were calculated is detailed in the Scoping Statement Document that was approved by USAID in May 2000. The scores of significance for environmental issues represent the following:*

4 = Highly Significant;
3 = Moderately-Highly Significant;
2 = Moderate-Low Significance; and
1 = Low Significance.

2.7 Significant Issues

Significant issues are those that scored 3 or 4 as shown in Table 2.1 either during the construction or operation stages of the Project. The significance score assigned to the environmental issues does not necessarily indicate the level of impact associated with the Proposed Action or with alternatives. These issues are discussed and assessed in detail in

the EA. The following is a summary of the issues deemed significant as a result of the Scoping Sessions.

Socio-Economic Conditions

- Employment and Economy

  This issue discusses the expected impacts of the construction and operation stages of the proposed project on employment opportunities. As a result of the proposed project direct and indirect work opportunities are expected to increase, standards of living and property values may be affected. In addition, an influx of people seeking employment may provide indirect benefits but may also place pressure on local utilities and services.

- Health and Safety

  Excessive noise, dust and vibration levels and disposal of wastes can pose an occupational health and safety hazard. There is also the risk of injury and accidents to the public as well as to workers during construction and operation as a result of heavy machinery and transportation among other activities.

- Aesthetics

  This issue concerns the effect of the proposed project during the construction and operation phases on the aesthetic value of Aqaba. Noise, odors, dust, and visual intrusion resulting from the construction and establishment of the Proposed Estate may affect the aesthetic value of the immediate area that encompasses an international airport. Odors and dust may also affect Aqaba town that is predominately down wind of the selected site.

- Archaeology

  This issue concerns the effect of the proposed project mainly during the construction stage on the archaeological resources. Numerous archaeological sites located in and around Aqaba have been recorded in the Jordan Antiquities Database and Information System (JADIS). These sites date back to a number of periods starting from the Epipaleolithic and Pre-pottery Neolithic periods, to the Umayyad-Fatimid, and Ottoman periods.

  The proposed project may damage or destroy known archaeological sites and/or new, undiscovered sites during construction, especially during drilling and excavation work. However, there are no JADIS records for archaeological sites in or immediately around the selected site; therefore, the main concern is related to those that are undiscovered/unrecorded or that are still buried.

Atmospheric Resources

- Dust

  Dust generated, mainly during construction from excavations, transportation, loading and unloading of construction materials, and movement of heavy machinery is expected due to the open desert-type nature of the selected site. Dust generated and transported by winds may temporarily affect visibility.

Winds may also carry dust to Aqaba town affecting tourism as well as the every day life of local residents. Winds carrying dust to the site may affect workers and general operating conditions at the Estate.

- Emissions

  Emissions generated from heavy machinery, transportation and operation of generators/compressors/boilers during construction and operation are expected and may reduce air quality as well as contribute, although not very significantly, to global greenhouse gases.

Natural Resources

- Soil Disturbance

  Potential soil disturbance may result from construction activities and include reduced soil stability, loss of soil structure, and soil erosion. Chemical disturbance or pollution of soils during operation may be related to inappropriate solid and liquid waste handling.

- Groundwater Resources

  Groundwater resources may be contaminated from wastewater, solid wastes, chemicals, and lubricants. Groundwater resources should also be considered in light of the scarcity of fresh water supplies as a potential source.

Other Issues

- Wastewater Disposal

  This issue is related to the expected impacts of wastewater disposal on environmental conditions in Aqaba. Options related to wastewater pre-treatment, wastewater quality, and the capacity of the municipal treatment plant will be considered. The municipal wastewater treatment plant in Aqaba is being studied for upgrade and expansion: the wastewater generated from the Proposed Estate is being considered in the study.

- Solid Wastes Disposal

  This issue is related to the possible impacts associated with disposal of wastes generated during construction and operation that include solid wastes, liquid wastes, construction materials, chemicals, and lubricants that may affect natural habitats as well as pose a threat to worker and public health.

- Water Consumption

  This issue concerns the various water requirements of the Proposed Estate and possible sources to satisfy these requirements. Water consumption should be considered in terms of the scarcity of freshwater resources in the area and the possibility of water reclamation and reuse.

- Environmental Permitting and Operating Procedures

  This issue is related to the operating procedures of the Proposed Estate as related to environmental monitoring and permitting. Setting up clear and thorough environmental guidelines and a mechanism for their implementation is the only way to ensure the environmental soundness of the Proposed Estate throughout the project cycle.

2.8 Non-Significant Issues

Non-significant issues are those that scored 1 or 2 as shown in Table 2.1 either during the construction or operation stages of the Project. The significance score assigned to the environmental issues does not necessarily indicate the level of impact associated with the Proposed Action or with alternatives. These issues are only briefly discussed in the EA. The following is a summary of the non-significant issues as a result of the Scoping Sessions.

- Traffic Disruptions

  Disruptions in traffic flow, especially during construction, may result from the movement of heavy machinery, transportation of construction materials and labor, and any excavations that cross roads. Traffic congestion, safety risks, and potential obstruction of airport and industrial traffic as well as highway emergency services may result.

- Seismic Risks

  The issue of seismic activity (earthquakes) in the Aqaba region was discussed and considered non-significant during scoping.

- Floodwater

  This issue was considered non-significant during the scoping process. It will be minimally discussed since the physical design team has incorporated provisions for flood protection of the Proposed Estate from flash floods.

- Noise

  This issue discusses the impact of the construction and operation of the Proposed Estate on noise levels in the vicinity of the selected site and its impacts on neighboring receptors. The impacts are determined by the level of noise and by the proximity and type of receptors.

- Flora, Fauna and Habitats

  Flora, fauna and their habitats are considered since Aqaba is located along major migratory bird routes and since the desert environment on which the project is encroaching upon is very delicate. Construction at the selected site and along infrastructure right-of-ways may affect natural habitats and associated species.

- Marine Ecology and Coral Reefs

  Marine ecology and coral reefs are being considered due to the associated high value and existing preservation efforts in the region. Although it is not expected that the proposed project will have any direct impacts on marine ecology due to the location of the selected site, off-site activities during construction and operation may have cumulative and indirect impacts on this valued resource.

3. Alternatives Including the Proposed Action

This chapter provides a description of the Proposed Action, other feasible alternatives and discusses some of their main advantages and disadvantages. A comparison, summarized in Table 3.3, is also made between these alternatives and the No-Action Alternative.

3.1 Demand for the Project

A demand study produced a number of investment scenarios based on demands for industrial space in Aqaba. The most feasible demand scenario included a combination of industries as part of a (QIZ) Qualified Industrial Zone (light and medium manufacturing, and warehouses for distribution) and local demand generated by current industries in Aqaba moving into the Proposed Estate (light and medium manufacturing). This demand scenario was based upon three development phases: Phase I would be up to 5 years; Phase II from 5 to 10 years; and Phase III from 10 to 20 years. Accordingly, the types of industries most likely to populate the Estate include:

QIZ Light Industries

- Packaging
- Toys and Sports Equipment (production from imported raw and intermediate materials)
- Optical Equipment

QIZ Medium Industries

- Textile Spinning and Weaving (production of fabrics, from imported intermediate yarns; no dyeing).
- Agro-Industries/Packaging
- Electronics Equipment Assembly (production of consumer electronics, PC boards, and intermediate assemblies from imported components; bonding and soldering).
- Consumer Appliances Manufacturing/Assembly (Assembly of white goods for the regional market).

QIZ Logistics and Warehousing

- Storage, bulkbreaking, and distribution of imported goods; inventory management, repackaging, and export staging.

Local Light and Medium Industries

- Metal Working Service Industries (truck repair, trailer fittings, engine and transmission rebuilding, electrical and mechanical repairs)
- Construction Materials (stone and marble products manufacturing, polishing, and processing)

3.2 Development Approach

The development approach that was followed in the Master Plan provides for the evaluation of the following separate industrial estate components in order to accommodate for the above-mentioned industries:

- Physical configuration, in terms of topography, access points, security fencing, individual plot layout, internal road network, and on-site utilities;
- Utilities and services networks, including water/wastewater, storm water drainage, electricity, and telecommunications;
- Size and layout of buildings, including common facilities (i.e. administrative buildings, fire station, medical clinic), speculative/advance buildings (i.e. standard factory buildings, shared units), and ancillary developments (i.e. parking spaces and landscaping); and
- Expansion phasing of the project over time based on cost-effective development increments.

Feasible alternatives, including the Proposed Action Alternative are derived from these separate industrial estate components. In general, construction is expected to commence during the year 2000 and operations of industries inside the estate are expected to initiate during the year 2001 under all alternatives.

3.3 The Proposed Action

The Proposed Action is a combination of preferred alternatives of the various selected industrial estate components. The preferred alternatives for these components that make up the Proposed Action are discussed below.

Selected Site, Location and Development Phases

The selected site location (Figure 3.2) has been studied previously during the 1997 JICA "Study on Development in the Southern Districts of Jordan" and was concurred during the 1999 TSG study on "Accelerating Private Investment in the Aqaba Region: Strategic Options for USAID".

The southern half of the 277ha site (Figure 3.1) has been selected over the northern portion for the three phases (130ha) of development: Phase I (0-5 years) 30ha; Phase II (5-10 years) 23ha; Phase III (10-20 years) 77ha. The reasons for this selection and the others discussed below are detailed in Section 5 of the Feasibility Study and are based on economic feasibility and other engineering-related factors. The proposed layout and Phasing is depicted in Figure 3.1.

Roads and Site Entrance

The main entrance to the site is perpendicular to the proposed airport highway (Figure 3.2). The main road network inside the Proposed Estate will follow an East-West axis, intersected by sub main roads running in a North-South direction. There will be 382m of main roads that are 30m wide with sidewalks and an island separator. Sub-main roads and secondary roads are 16m and 14m wide, and make up a total of 851m and 751m in length respectively. Cross sections of the internal roads are shown in Figure 3.3.

Figure 3.1: Site Layout and Development Phasing

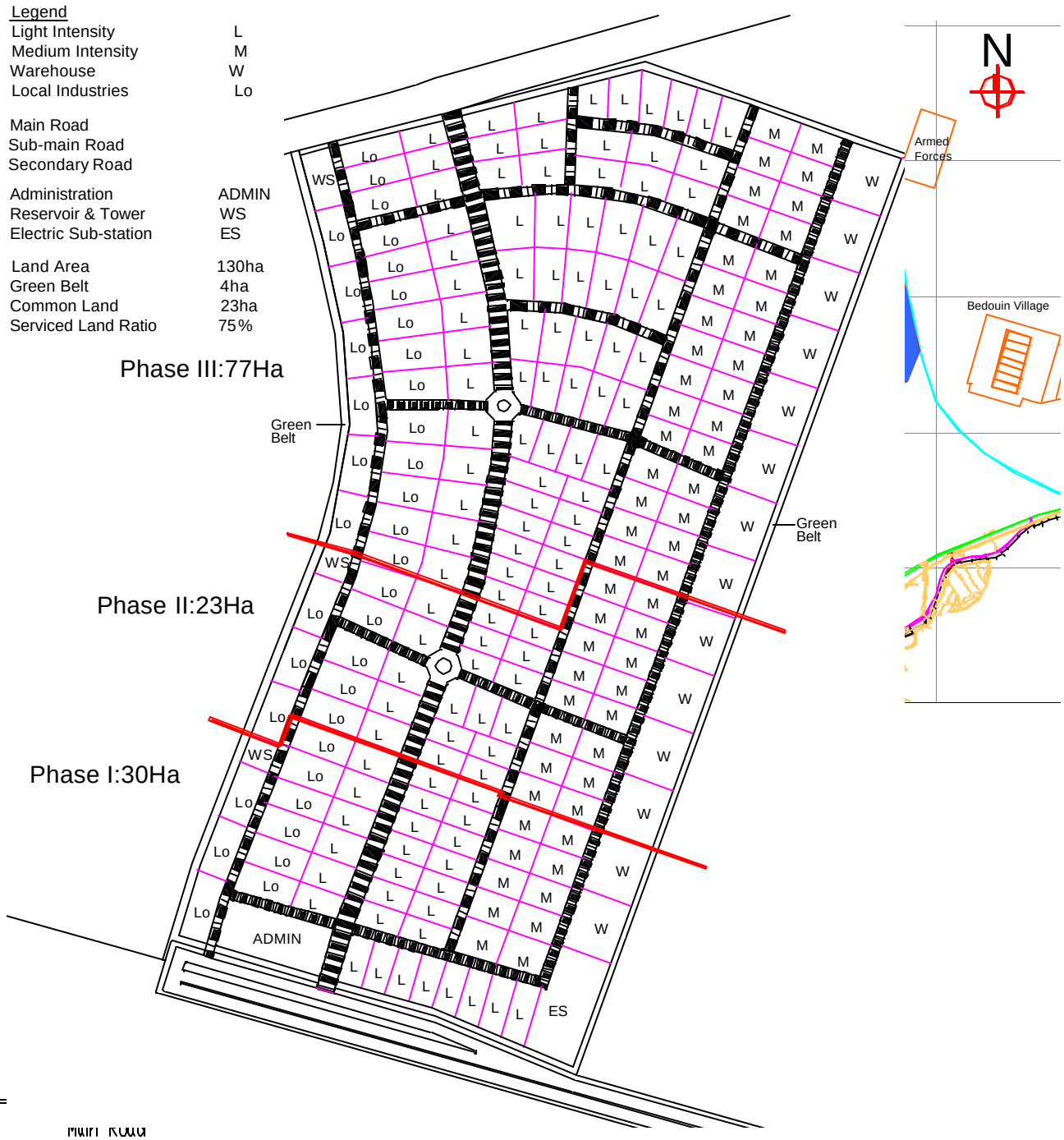
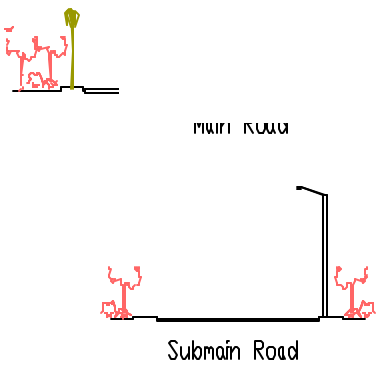


Figure 3.2: Site Location, Entrances and the Proposed New Highway

Figure 3.3: Cross Sections of Internal Roads



There is a need to construct an exit and entry ramp (road) for the site from the Proposed New Airport Highway for

easy traffic flow. This ramp will have a width of 14m and a length of 720m with one sidewalk separating it from the Proposed New Airport Highway. An intersection or tunnel would also be required for southbound traffic to enter the site.

USAID has proposed to fund the construction of part of the Proposed New Airport Highway (Figure 3.2) that will be expanded in the future as a full substitute for the Existing Dead Sea Road. This would include an upgrade of 1.8km of the existing highway to the point where the new highway deviates from the old one and construction of 3.75km of new highway to the Estate's entrance. Construction of the proposed highway and the connecting ramps need further investigation and would require separate environmental assessments. Moreover, it is planned to align off-site utility connections with the proposed new highway.

Wastewater and Surface Water Run-off

Wastewater generated within the Estate from the various investors' operations is expected to result from sanitation and domestic-type usage; non-domestic-type wastewater will not be collected. The wastewater will be conveyed by gravity, to the lowest point, the southwestern corner of the selected site. From this main collection point a pipeline (2,600m^3/day capacity) needs to be constructed to connect with the Aqaba Municipal Wastewater Treatment Plant (AMWWTP) located approximately 4km SSW of the selected site. The total sewage effluent upon full development (20 years: all three Phases) from the Estate is not expected to surpass 2,600m^3/day since that is the maximum expected water demand (Table 3.1). Wastewater delivered to the AMWWTP will need to conform to the Jordanian Regulations Governing Discharge of Industrial & Commercial Wastewater Into the Sanitary Sewer System (Annex B, Table B-1). Surface run-off from within the site is not expected to be significant. However, surface run-off flowing from the mountains to the east requires drainage ditches to protect the Estate from infrequent, but potentially damaging flash floods.

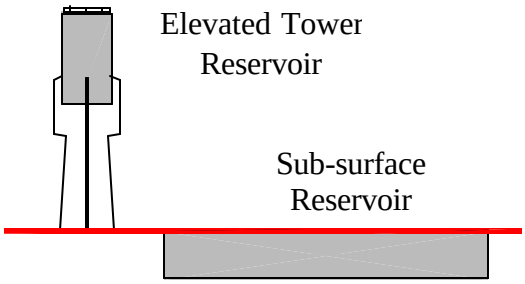
Water

The total expected water demands according to Development Phase is shown in Table 3.1. These water demands include demands for landscaping and support services as well as sanitation and domestic-type demands. In general, 20m^3/ha/day has assumed as the standard unit water demand for the Estate. These water demands will be met from the Aqaba Water Authority. A 2,600m^3/day capacity pipeline will need to be constructed to supply this water from 4km south of the site that would be aligned with the Proposed New Airport Highway (8km total length). In addition, sub-surface and elevated reservoirs will be constructed for each Development Phase along with an associated distribution and pumping system. Table 3.1 also shows the reservoirs capacities proposed and Figure 3.4 shows a typical elevated water reservoir.

Table 3.1: Water Demands and Reservoirs According to Development Phase

Development Phase	Area (ha)	Demand (m^3/day)	Reservoirs Capacity (m^3)	
			Sub-surface	Elevated
Phase I (0-5 years)	30	600	600	53
Phase II (5-10 years)	23	460	460	38
Phase III (10-20 years)	77	1,540	1540	128
Total	130	2,600	2,600	219

Figure 3.4: Typical Water Reservoirs



Treated wastewater requirements for reuse would be pumped from the open storage reservoir proposed approximately 200m south of the Estate under the "Upgrading and Expansion of Water and Wastewater Facilities at Aqaba" Project. This water will supply the landscaping and irrigation requirements of the Estate.

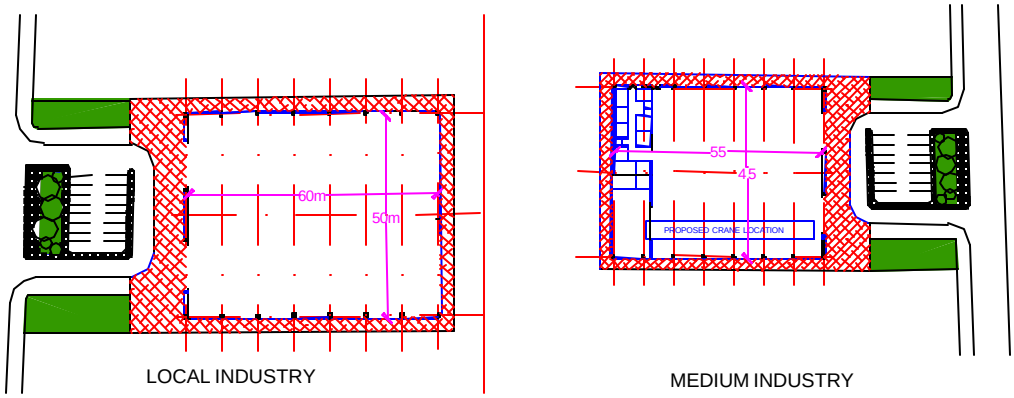
Built Up and Serviced Areas

The Proposed Action opts for developing 75% of the 130ha site (Figure 3.1) as individual plots for investor use while the remaining 25% will be common land. Common land includes roads, services and bare areas. Of the 75% plots' areas, a 60% Under-roof Space to Plot Area Ratio has also been adopted in accordance with the maximum limit set by JIEC; essentially this means that 60% of the plot can be placed under a roof in a manner as seen fit by each investor.

Buildings

Under the Proposed Action, 5% of Phase I, including ancillary buildings will be developed for immediate use by investors as a kick-start for the Estate. Prototype factory units for medium, light and local industrial use will be built. A combined steel and concrete frame was chosen for these pre-built factory units as shown in Figure 3.5 and 3.6. Ancillary buildings that will be constructed include a fire station, medical facility, mosque and commercial services/management center (Figure 3.7). These ancillary buildings are to be built on the smallest area required for these buildings for cost effectiveness.

Figure 3.5: Typical Factory Units



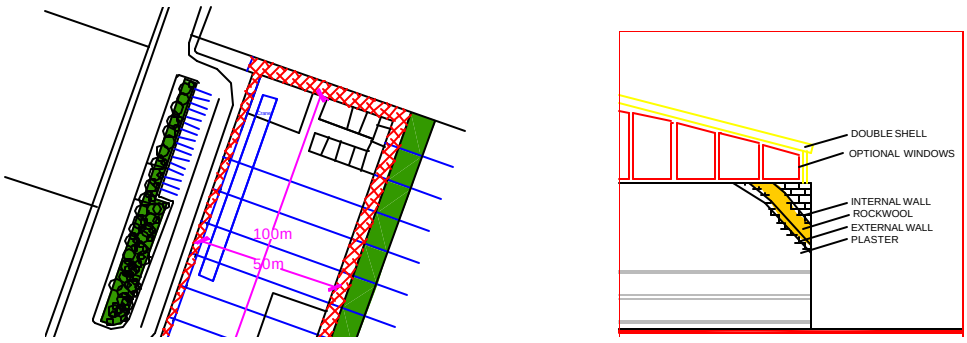
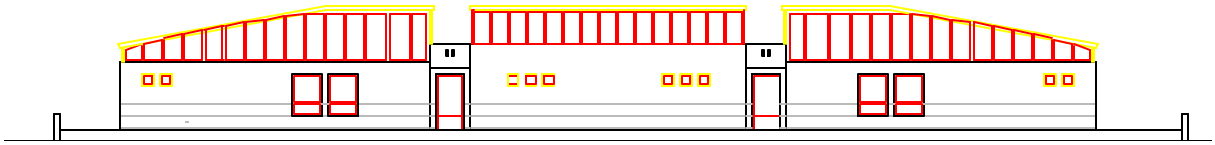


Figure 3.6: Typical Concrete-Steel Structure



The structures as depicted in Figure 3.5 and 3.6 will have a steel frame and rock wool insulated concrete walls. The roof or shell will be made of steel sheets also insulated with rock wool. The shell will also be designed for optional windows and ventilation. The purpose of insulation is to help keep the heat out in the summer and keep heat in during the winter. Set backs are 10m from the front and back and 5m from the sides.

Figure 3.7: Ancillary Buildings

Landscaping

Landscaping will involve planting of a green belt around the perimeter of the entire Estate for wind protection and aesthetics. Trees and shrubs will be planted along roads as depicted earlier in Figure 3.3 for shade and aesthetics. A park will also be provided as

shown in Figure 3.6 and tree-shaded benches will line the sidewalks of the Main Roads. An irrigation system will be setup for landscape irrigation.

Electricity and Telecommunications

The estimated electricity and telecommunications demands are shown in Table 3.2. To satisfy these electricity demands, a 132kV/33kV primary power substation would need to be built on site. Dual overhead 132kV transmission lines, mounted on 32m high towers with a 335m spacing would connect the primary substation with a substation (A2) in Aqaba that is approximately 4km south of the Estate operated by the Aqaba Electrical Distribution Company. The A2 substation in Aqaba would require some upgrading. The transmission lines, similar to the water main, would be aligned with the Proposed New Airport Highway and would measure approximately 8km in total length.

Telecommunication demands will be satisfied by the Jordanian Telecommunications Company. Subsurface fiber-optic cables, also running along the Proposed New Airport Highway, will connect the Estate with a remote line unit having a capacity of 800 lines expandable up to 1600 lines.

Table 3.2: Electricity and Telecommunications Demand

Component	Electricity Demands (MW)			
	Phase I	**Phase II**	**Phase III**	**Total**
Factories	14	10.25	34	58.25
Ancillary Buildings	0.35	-	-	0.35
Utilities	1.5	-	-	1.5
Street Lighting	0.04	0.04	0.07	0.15
Total Electrical Demand	15.9	10.3	34.07	60.20
	Telecommunication Demands (Lines)			
Total Lines Required	191	125	495	849

3.4 Other Feasible Alternatives

Other feasible alternatives are closely related to the Proposed Action as described above. The main differences between the Proposed Action and other feasible alternatives lie in the selection of the separate industrial estate components with environmentally different consequences as related to developed portion of the site, wastewater, water supply, access roads, built-up and serviced area ratios and development phasing. A summary comparison between the feasible alternatives and the Proposed Action, in addition to the No-Action Alternative is provided in Table 3.3 at the end of this chapter.

Site Selection Alternatives

This environmental assessment does not asses the site selection for the proposed Aqaba International Industrial Estate, since site selection was assessed in the 1997 JICA "Study on Development in the Southern Districts of Jordan" and was concurred during the 1999 TSG study on "Accelerating Private Investment in the Aqaba Region: Strategic Options for USAID".

As a result, various sites were identified in the Southern districts of Jordan, of various sizes and for different types of industrial use. The Proposed Action site location was

selected for Aqaba International Industrial Estate (AIIE) in Aqaba Governorate. Three siting options for locating of AIIE were studied. The three sites are all located north of Aqaba town. The three locations were screened during the previous studies according to the following criteria:

- Access to urban facilities, accumulation and availability of labor force;
- Safety from flash floods
- Access to transport facilities, in particular international trading port, major highways and international airport; and
- Site conditions including topography, geology and current land use.

The selected site location was chosen as the best possible location for the establishment of the Aqaba International Industrial Estate. Other issues were also taken into consideration and these include the effect of the site on vegetation cover, flora and fauna, vulnerable groups (women and Bedouins), employment, social conditions, population growth and floodwater.

The site assessment conducted does not reveal any differences in negative impacts with regards to any of the above mentioned issues among the three siting options, however does reflect more positive impacts in terms of employment creation and socio-economic development of the region with the selected option.

Developed Site Portion Alternative

Developing the northern portion of the site as opposed to the southern portion of the site is the other alternative. This alternative however is less appealing as a result of anticipated traffic flow problems, increased distances for utilities' connections and other factors. In addition to these factors, the northern portion of the site is less anthropogenically disturbed. The northern portion has fewer off road tracks and overall human disturbance is less evident. This lack of disturbance resulted in more acacia trees, rocky outcrops and undisturbed natural habitats in general.

Wastewater Alternative

In the Proposed Action, wastewater from the Estate will be collected and conveyed to the AMWWTP. The only major threats the Proposed Action poses are related to jeopardizing municipal treatment capabilities and risks associated with wastewater conveyance line damage and spills. These can be minimized with appropriate wastewater monitoring and environmental operating procedures.

The other alternative is to construct an on-site wastewater treatment plant (WWTP). This option was not studied in detail since it would be significantly more costly under the assumptions that the AMWWTP will be able to handle the loads (quality and quantity) conveyed to it and that only sanitary and domestic-type sewage will be generated and collected.

An on-site WWTP would also likely create undesired odors at the Estate and the treated effluent, other than that taken for reuse, would still require appropriate disposal. Annex B, Table B-2 presents the Jordanian Standards 202/1991; *Requirements for Discharges of Industrial Effluents* that would need to be met if an on-site WWTP was opted for. Under both options, the Aqaba International Airport could potentially join the Estate's wastewater collection, treatment and disposal schemes as opposed to continuing its current

wastewater disposal practices (septic tanks of unknown condition combined with occasional septic pumping).

Water Supply Alternatives

Two alternatives were looked at with respect to water supply other than that described in the Proposed Action. The first option looked into on-site desalination of brackish groundwater presumed to exist under the site and the second option looked into off-site desalination of seawater. Both of these two options present the problem of brine disposal and are significantly more costly than a municipal connection in terms of capital, operation and maintenance costs. Desalination however, would be considered a more reliable source in the long run when bearing in mind the scarcity of fresh water resources in the area.

Access Roads Alternative

The Proposed Action involves the construction of approximately 3.75km of new highway, associated exit-entry ramps, and upgrade of approximately 1.8km of the existing Dead Sea Road. These activities, in addition to the Proposed Safi Back-road (Figure 3.2) are expected to occur with or without this Proposed Estate's development and require separate environmental assessments. The other option involves construction of a temporary access road from the eastern entrance of the site, perpendicular to the existing Dead Sea Road with associated exit-entry ramps. This road would have to be removed once the Proposed New Airport Highway is developed.

Building and Serviced Areas Alternative

The Proposed Action chooses a 75% Plot to Common Land Area Ratio and a 60% Under Roof Space to Plot Area Ratio. The other alternative looked into is adopting a less dense configuration; i.e. smaller Plot to Common Land Area and Under Roof Space to Plot Area Ratios on the same raw 130ha area. The less dense configuration is less feasible from an economic viewpoint in terms of the number of investors that can be accommodated for. If a larger area of raw land was considered with a less dense approach, a similar number of investors could be accommodated for however, the unit costs per investor, plot or hectare would increase.

Phasing Alternatives

The scheduling (years) and areas (hectares) adopted for Phases I, II and III in the Proposed Action are based on the Demand Study conducted. Alternatives would vary the areas and scheduling chosen for each Development Phase. From an environmental point of view, the only difference that would result is related to risk of unexpected non-development or unforeseen lack of demand. In other words, there is a risk that the areas developed may have not needed to be developed, resulting in unnecessary environmental impacts.

3.5 No-Action Alternative

The No-Action Alternative implies not developing the Aqaba International Industrial Estate as described under the Proposed Action or any of the other feasible alternatives. However, since a demand for industrial space has been established and the area including

and around the Proposed Estate has been designated in Aqaba's Master Plans as an industrial zone, similar industrial developments in the immediate area should be expected.

This project proposes to provide an organized and well-serviced estate for locating of industries. Furthermore, in light of a recent governmental decision to transform Aqaba into a Special Economic Zone, further intensifying pent up demands for industrial space, the No-Action Alternative would not result in the area being left undeveloped. The only benefit which could be foreseen regarding development of a similar estate downwind (as opposed to upwind as in this proposal) of Aqaba would be related to risk of air pollution. However, air pollution will be controlled in light of the selected site's location by the types of industries allowed to establish and environmental monitoring and operating procedures.

The No-Action Alternative has several disadvantages these are, among others:

- Development would be allowed to occur in an uncontrolled manner, where industries may locate all over Aqaba's outskirts negatively affecting environmental conditions and aesthetics;
- Reduced regional competitiveness in attracting industries especially in the field of technology;
- Existing repair shops servicing the transportation industries would remain in their current uncontrolled location affecting the environment and aesthetics of Aqaba;
- Undetermined possibility for lack of environmental soundness of operation of industries that could be established under a different scenario; and
- A lack of uniform environmental standards governing industries that would establish in the area.

A summary comparison between the feasible alternatives and the Proposed Action, in addition to the No-Action Alternative is provided in Table 3.3 that follows.

Table 3.3: Environmental Consequences of Alternatives during Construction and Operation

Issues / Alternatives	Employment and Economy	Health and Safety	Aesthetics	Archaeology	Dust	Emissions	Disposal of Wastewater	Disposal of Solid Wastes	Marine Ecology and Coral Reefs	Soil Disturbance & Contamination	Flora Fauna and Habitats	Water Consumption	Groundwater
No-Action Alternative	Worsening in socio-economic conditions with population growth and limited employment opportunities	If haphazard industrial development does occur, health and safety of Aqaba population and tourists would be affected through uncontrolled emissions and wastes	No effect on current site. Industrial development closer to the town may negatively affect Aqaba aesthetics.	No impact on the site If development occurs elsewhere in Aqaba there may be increased risk of encountering archaeological artifacts.	No impact	No impact on the site. If development occurs anywhere closer to the town of Aqaba, it may have negative effects on ambient air quality in Aqaba town	If industries are developed without proper control there may be increased possibility of improper disposal of industrial wastewater	No effect on current site	No impact	No effect on current site Other sites may be affected if industrial development occurs elsewhere	No effect.	No effect	No effect on current site. If industrial development occurs in another location, groundwater in that location may be impacted.
1. Developed Site Portion Alternative													
PA: Southern Part	C&O: Shorter transit time and distance for workers from Aqaba town	N/A	C&O: Less effect since the area is already disturbed by the airport to the west and the Free Zone Corporation to the south	C: No archaeological artifacts located	C: Dust raising given winds blowing in the western direction would affect visibility in the airport and the Dead Sea Road	C&O: None to minimal effects are expected on Aqaba town	C&O: lower C&O costs since option is closest to the AMWWTP	O: Lower operation costs since option is closest to Aqaba municipal landfill	C&O: No effects since the site is far from the coast	C: Soil disturbance related to construction works O: No effect	C: May destroy flora, fauna and habitats, though the site is anthropogenically disturbed and the habitat fragmented O: No effect	N/A	N/A
Northern Part	C&O: Longer transit time than PA	N/A	C&O: More negative effect than PA since it is further north into the desert where there is minimal visual intrusion	C: Possibility of encountering archaeological artifacts though none are documented to exist in project site	C: Dust raising given winds blow in the western direction would affect visibility at the Dead Sea Road	C&O: Same as PA	C&O: Site farther than PA, higher costs of main construction and operation	C&O: Farther to Aqaba municipal landfill than PA	C&O: Same as PA	C: Soil disturbance to a higher extent due to higher distance. O: No effect	C: Higher effect than PA since the area is less disturbed and habitats are less fragmented O: No effect	N/A	N/A
2. Roads:													
PA: Proposed New Airport Highway	C: Creation of new employment opportunities	A separate environmental assessment is required	A separate environmental assessment is required	A separate environmental assessment is required	A separate environmental assessment is required	A separate environmental assessment is required	A separate environmental assessment is required	A separate environmental assessment is required	A separate environmental assessment is required	A separate environmental assessment is required	A separate environmental assessment is required	A separate environmental assessment is required	A separate environmental assessment is required
Proposed Safi Back Road	C: Creation of new employment opportunities	A separate environmental assessment is required	A separate environmental assessment is required	A separate environmental assessment is required	A separate environmental assessment is required	A separate environmental assessment is required	A separate environmental assessment is required	A separate environmental assessment is required	A separate environmental assessment is required	This Alternative will or will not occur irrespective of the Estate outcome. Therefore a separate environmental assessment is required to assess its environmental consequences	A separate environmental assessment is required	A separate environmental assessment is required	A separate environmental assessment is required
Temporary Road to Dead-Sea Road	C: Creation of less new employment opportunities due to smaller road size	O: Increased traffic may increase risk of road accidents	C&O: Minimal effect since a dirt road already exists and is used by drivers	C: No archaeological remains discovered Possible unearthing of archaeological artifacts	C: Minor dust raising O: Decrease dust raising from existing dirt road	None	N/A	N/A	N/A	C: Minimal effect since dirt roads already exist and are widely used O: Minimal effect	C: There is a widely used dirt track road. None to minimal effects are expected.	N/A	No effects
3. Wastewater Treatment													
PA: pump to AMWWTP	N/A	O: Possible wastewater leakage from pipes	C: Visual intrusion during pipe laying O: No effects since pipes will be laid underground	C: Will not encounter any archaeological remains since pipe will be in the right of way of existing roads	C: Dust may result during the construction of pipe main	No effect	O: Strict quality parameters are to be applied. Only domestic wastewater to be pumped to AMWWTP	O: Biosolid waste from the treatment process would be handled by the AMWWTP	O: No discharges into the sea are expected	C: Minimal disturbance since pipe construction would be in the right of way of the road O: No effect	C: No effect since piping will be in the right of way of existing/proposed roads O: No effect	N/A	No effects
On site Treatment	N/A	C&O: No health and safety effects are expected	C: No aesthetics effects are expected	C: Same as PA	C: Dust within and as part of the Estate construction activities	No effect	O: May be designed to treat wastewater of various qualities	O: Biosolids would have to be handled according to method of treatment, i.e. Additional solid waste quantities	O: Same as PA	C: Disturbance within site only O: No effect	C: No effect since all the site will be disturbed O: Brine disposal may affect flora and fauna at disposal site	N/A	O: Possible contamination through wastewater seepage into groundwater depending on the selected method of treatment

PA: Proposed Action C: during Construction Phase
O: during Operation Phase C&O: during Construction and Operation Phases
N/A: Not applicable

Table 3.3 Continued…

Issues / Alternatives	Employment and Economy	Health and Safety	Aesthetics	Archaeology	Dust	Emissions	Disposal of Wastewater	Disposal of Solid Wastes	Marine Ecology and Coral Reefs	Soil Disturbance & Contamination	Flora Fauna and Habitats	Water Consumption	Groundwater
4. Water Supply													
PA: Municipal Water Supply	C: Employment opportunities only within construction phase	N/A	N/A	C: No archaeological features will be encountered or affected	C: Pipe construction may raise some dust though it is supposed to be in the right of way of the road. The effect magnitude is none – minimal	No effect	N/A	C: Solid wastes related to pipe construction O: No effect	No effect	C: Disturbance due to pipe construction minimal and short term O: No effect	C: Water supply piping will be in the right of way of existing and proposed roads. An environmental assessment will be conducted for the proposed road	N/A	O: Use of fresh Disi water
Off Site Desalination of Seawater	C&O: More new employment opportunities than PA, since construction and operation would be off site	The site will have to be assessed if the option and potential sites are chosen	The option will have to be assessed separately	The site will have to be assessed if the option and potential sites are chosen	The site of the desalination plant will have to be assessed if the option and the site are selected	The effect on the emission levels will have to be studied once the option and sites are determined	N/A	C: Higher construction related solid wastes than PA O: Disposal of brine would be an issue	C: May affect marine life since it will be built close to shore O: Brine disposal and intake location might affect corals if this option and site are selected a detailed study would be required	C: Disturbance at selected site O: Disturbance of marine soil cover	A separate environmental assessment will be required once option and site are selected	N/A	O: Considered the optimal long term solution for water supply for industrial use
On Site Desalination of Brackish Water	C: Same as PA O: Employment opportunities will be available to operate the on site desalination plant	The site will have to be assessed if the option and potential sites are chosen	N/A	Same as PA	Dust raising would be part of the Estate construction activities	No effect	N/A	C: Increased solid waste than PA O: Disposal of brine would be an issue	C: No effect O: Brine disposal into the Gulf may affect marine life. If this option is selected more study will be required	C: Disturbance of soil within site O: No effect	C: Minimal effect since all effects will be concentrated on Estate site O: Improper brine disposal may affect flora, fauna and habitats in disposal site	N/A	O: May affect brackish groundwater aquifer. Further study is required if option chosen.
5. Built up & Serviced Areas													
PA: 75% Plot to Common Land Area	O: Highest employment opportunities	Higher risk of incidents due to higher number of installations	Aesthetically most intrusive	C: Under ground archaeological features may be encountered during excavations if present	Highest construction activity: highest potential to raise dust	Higher construction rates and therefore higher emission levels would be expected	Higher wastewater releases	C: Increase solid wastes O: Higher number of factories, therefore increased solid waste generation	No effect	C: Highest soil disturbance O: No effect	C: Destruction of flora and habitats, though the effect is minimal since the site is disturbed and the habitat is fragmented O: No effect outside the Estate boundaries	C & O: Highest water consumption due to highest number of expected installation	Minimal replenishment of groundwater aquifer
PA: 60% Under Roof Space	Highest employment opportunity	Higher risk of incidents due to higher number of installations	Aesthetically most intrusive	C: Under ground archaeological features may be encountered if present	Highest construction activity, therefore highest potential to raise dust	Higher construction rates would lead to higher emission levels	Higher wastewater releases	C: Increased Solid waste O: Higher number of industries, therefore increased solid waste generation	No effect	C: Highest soil disturbance O: No effect	C: Destruction of flora and habitats, though the effect is minimal due to current disturbance and fragmentation of habitat. O: No effect outside the Estate boundaries	C & O: Highest water consumption due to highest number of expected installations	Minimal replenishment of groundwater aquifer
Less Dense Configuration:	Less than PA	Less risk of incidents than PA	Less than the PA	Same as PA	Less potential for dust raising than PA	Construction related emission levels less than PA	Less than PA	C: Less construction debris O: Less solid wastes than PA	No effect	C: Less than PA O: No effect	C: Same as PA though to a lesser extent O: Same as PA	C&O: Less water consumption than PA	Higher replenishment of groundwater aquifer due to smaller built area
6. Landscaping													
PA: Green belt and Besides Roads	O: Employment opportunities will be available for irrigation and care of landscaped areas	Possible spread of air borne diseases through improper irrigation methods such as sprinkling	Improve aesthetics on and around the site	No archaeological features will be encountered or affected	Will decrease dust, provide a soil cover, and minimize effects of desert dust winds on the estate and the town	No effect	N/A	C: N/A O: N/A	No effect	C: No effect O: Decrease effect of soil disturbance and contamination and provide vegetation cover	C: No effect O: Planting indigenous species such as Acacia and palm trees would restore some of the destroyed habitat	O: Reclaimed water will be used for landscaping purposes, therefore will not affect fresh water supplies	Percolation of water used for irrigation

PA: Proposed Action C: during Construction Phase
O: during Operation Phase C&O: during Construction and Operation Phases
N/A: Not applicable

4. Affected Environment

The following chapter presents a discussion of the existing and potentially affected physical, biological and socio-economic environmental conditions of the study area.

4.1 Physical Environment & Infrastructure

Climate

The Gulf of Aqaba lies within a very warm portion of the Saharan-Sudanese bio-climatic zone. The climate is arid with high temperatures and is affected by airflow from the Indian monsoon trough and the Mediterranean low-pressure system. The latter creates cooler and unsettled conditions generally during the period November through March. In general there are prevailing dry land to sea winds that reduce moisture transport, producing low rainfall along with high evaporation. [20]

Mean monthly air temperatures range from 12°C in January to 33°C in August (Annex C, Table C-1). Mean daily maximum temperatures range from 20°C in January to 40°C in July-August (Table 4.1). Mean daily minimum temperatures range from 6°C in January to 26°C in August (Annex C, Table C-2). Rainfall occurs mainly during November through May and averages approximately 35 mm/year (Annex C, Table C-3). Relative humidity averages between 32% and 52% during the summer and may reach 63% during the winter (Annex C, Table C-6). Evaporation rates are high and can reach up to 20 mm/day due to low humidity high solar radiation (Annex C, Table C-4).

Northerly winds (blowing towards the south) dominate and can be characterized as follows: N 38%; NNE 47%; ENE 3%, ESE-S-SSW 6%; and SWS-W 1% of the time. In terms of speed Beaufort 0 occurs 12%; Beaufort 2 (4-6kn) 21%; Beaufort3 (7-10kn) 35%; Beaufort 4 (11-16kn) 28%; Beaufort 5 (17-21 kn.) 3%; and Beaufort 6 (22-27kn) 1% of the time.

Table 4.1: Monthly Mean Maximum Daily Temperature in °C at Aqaba Airport Meteorological Station

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg.
1990	19.6	20.7	25.1	30.8	34.2	37.9	39.5	38.5	35.2	33.2	29.4	23.5	30.6
1991	19.9	22.7	26.9	32.1	34.6	38.4	38.2	38.0	35.2	32.6	27.0	19.6	30.4
1992	17.4	18.3	23.5	29.2	33.9	38.1	38.5	39.4	35.7	33.7	26.2	19.5	29.4
1993	18.2	19.7	24.7	31	33.7	38.9	39.5	40.4	36.6	34.1	26.8	22.7	30.5
1994	20.9	21.8	25.3	32.7	36.0	37.6	39.2	39.5	37.7	34.5	25.4	19.6	30.9
1995	20.6	22.0	26.2	29.3	35.1	39.8	39.4	39.1	37.4	31.6	24.8	21.3	30.5
1996	20.4	23.0	24.9	30.2	36.6	37.6	40.1	39.6	37.7	31.9	27.7	23.7	31.1

Topography and Landscape

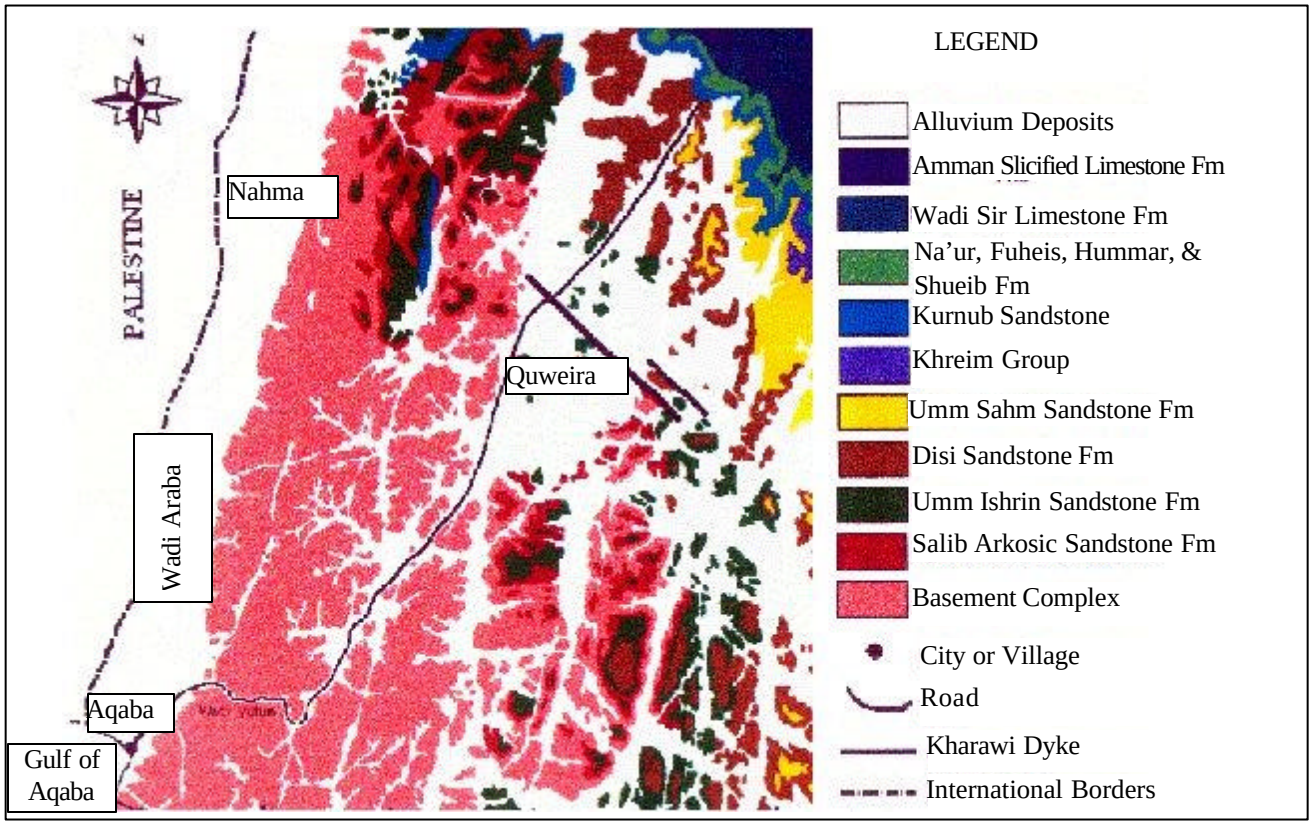
The land of the selected site is gently undulating, generally ascending towards the east. The site has a gradient of 2.4% to 4.4%, and the elevation varies between 80 - 126 masl.

In other words, there is a 46 m difference between the highest and the lowest points within the selected site. There are several small wadis and occasional rock outcrops scattered throughout the study area. The rocky outcrops are more evident in the northern portions of the site. The selected site is situated between Wadi Abu Sidra to the northeast and Wadi Yutum to the southeast.

Soil, Geology and Seismicity

The selected site is located on an alluvial fan formed from surface water flows that deposit sands and gravels. Figure 4.1 provides a small-scale geological map of the Aqaba Region. Soils in the study area are mostly composed of sandy and sandy hammada with some granite fragments and saline soils. The origin of sand is attributed to the archaic igneous rocks of the mountain ranges that surround Aqaba and Wadi Araba (granites, porphyry, dolorites, etc). Sands produced from their decomposition accumulate as dunes and sandy plains. The soil is not fertile and supports only the growth of plants well adapted to unfertile soils and low moisture levels. The depth of soils varies at the selected site and its subsurface geology, in general has not been studied and is therefore unknown. [32, 34]

Figure 4.1: Geological Map of the Aqaba Region



Between 1994 and 1997 15 earthquakes were recorded in the area (between 34°54' and 35°08'E latitude and 29°21' and 29°40'N longitude). The highest magnitude occurred in 1995 (Table 4.2). There were no reported damages to industries resulting from these earthquakes.

Table 4.2: Seismic Events in the Study Area[1]

Date			Location		Magnitude
Year	Month	Day	Latitude	Longitude	
1994	February	03	`	34.77	5.10
	September	01	29.32	34.86	3.20
	November	07	29.31	34.96	-
1995	March	21	29.36	34.97	-
	November	23	29.33	34.75	5.70
	November	24	29.31	35.08	4.50
	November	29	29.35	34.83	4.10
	December	01	29.33	34.69	4.40
	December	02	29.31	34.66	4.60
1996	January	08	29.25	34.73	4.40
	January	17	29.25	34.60	-
	February	02	29.24	34.67	4.50
	February	02	29.23	34.66	4.00
	February	12	29.22	34.68	4.10
	April	11	29.25	34.96	3.20
	December	02	29.21	34.63	-
1997	February	21	29.14	34.65	4.4
1999	December	08	29.30	34.80	4.0
2000	March	09	-	-	5.4

1 Seismic design codes currently used in Jordan are: (a) Jordanian National Code, Code of Loads and Forces (Zones A, B, C, and D; Zone A is adopted for Aqaba) and the Uniform Building Code, 1988, USA (Zones 1,2,3, and 4; Zone 3 is used for Aqaba).

Freidman (1985) has revi0ewed and summarized the understanding of the tectonic framework of the Gulf of Aqaba. According to Freidman, the mid-oceanic rift system borders on the continental plate in the Red Sea. This Red Sea rift system is breaking up the once continuous Arabian-African plate. At the north of the Red Sea, the rift splits into the western Gulf of Suez and the eastern Gulf of Aqaba. The Red Sea spreading center ends at the junction with the Gulf of Aqaba and the tectonic plate boundary continues as a transform fault zone. This transform fault zone is known as the Gulf of Aqaba – Dead Sea rift and extends from the Red Sea to the Zagros-Taurus Mountains in Turkey. The rift along with that of the Red Sea rift is splitting the continental mass into the Arabian and African Plates.

Strike-slip faulting has resulted in many grabens. The major grabens are from south to north: the Gulf of Aqaba, Wadi Araba, the Dead Sea, and the Sea of Galilee. Together with this strike-slip faulting, extensive uplift was experienced in areas adjacent to the rift. It is believed that this strike slip movement is still active but is periodic rather than continuous.

Air Quality

Air quality in the study area is greatly dependent on wind velocity (Annex C, Table C-7 and C-8). Predominately winds are northerly and since there are no significant sources of air pollution north of the town, Aqaba enjoys acceptable air quality in terms of SO_x and NO_x measurements.

Strong winds occasionally carry large quantities of dust, especially during the Khamasini and Toz wind periods (Annex C, Table C-9). A change in wind direction from northerly to southerly usually draws phosphate dust from the loading berths towards the town. Furthermore, the town is affected by the exhaust emissions from cars and several diesel-operated trucks. Recently, trucks have been prohibited from passing through the center of Aqaba in order to reduce associated traffic congestion and air and noise pollution.

Water Resources

Surface water is limited in Aqaba region. Flash floods occur during winter as a result of high intensity rains. These surface waters are not exploited; rather they empty into the Gulf of Aqaba via storm drains and natural surface runoff courses. Some of the surface waters resulting from winter rains infiltrate and recharge some of the groundwater resources, especially in Wadi Araba area. There is a relatively low risk of flash floods at the selected site. The 1 in 100 year (100-year return period) flash flood coming from the mountains northeast of the site is estimated at approximately 146 m^3/sec through Wadi Um Sidra.

The Southern Wadi Araba aquifer, which in Aqaba is mostly used for the Palm Irrigation Project is assumed to exist (at depths unknown) under the selected site. This aquifer is estimated to provide a safe yield of 5.5 MCM/year, and in 1991, abstractions were in the order of 4MCM/year [12].

The groundwater in the vicinity of the selected site and the AMWWTP, associated with the Southern Wadi Araba aquifer, is mainly of a sodium chloride type, and is generally found at shallow depths. The soil type in the area of the AMWWTP is mostly of sandy type with very little clay content, which facilitates wastewater infiltration to the groundwater. Tests performed on the water quality of the effluent from the Plant, as well as on the Palm Tree Wells #1 and #2 (the closest sampling conducted near the selected site) showed high nitrate, biological oxygen demand (BOD) and Ammonia (NH_4) levels (Table 4.3).

The quality indicators shown in Table 4.3 along with a general rise of the water table in the past years indicates wastewater infiltration into the Southern Wadi Araba basin as well as some saline intrusion, especially closer to the sea shore [35, 36]. Aqaba Town however, is mainly supplied with fresh water from the Disi and Wadi Yutum aquifers. These two aquifers are far from industrial areas; therefore they are not affected by industrial and transport activities in the city, as far as water quality is concerned.

Approximately 16 MCM in 1999 of the Disi withdrawal was used in Aqaba through a conveyance line with a maximum annual design capacity of 20.9 MCM [8]. Future increases in Disi water abstractions are not expected to supply Aqaba with significantly more water, since the MWI has placed a cap of 17.5 MCM/year of Disi to be abstracted for Aqaba town use. The Wadi Yutum Aquifer, south east of the selected site supplies approximately 2MCM annually. This aquifer is recharged from infiltrating floodwaters and from subsurface inflows originating from the Disi aquifer [9].

The Disi aquifer has been used as a water supply source for nearly 20 years. Throughout this period, extensive sampling has been conducted on its water quality. Water quality of the Disi aquifer is considered good. EC (salinity) values range from 300 to 600 µS/cm. Concentrations of Ca, Mg, Na, K, Cl, SO_4, HCO_3, NO_3, as well as of that of trace elements are low and Oxygen content ranges from 5.5 to 7.5 mg/l. Water quality has not changed

significantly throughout the 20-year abstraction period. Water from the Wadi El Yutum aquifer is considered of good quality for all uses as well, even though it is associated with higher EC values ranging from 1000 to 1100μS/cm. Nitrate levels, however are low. [9]

Table 4.3: Groundwater Quality of the Southern Wadi Araba Aquifer at Palm Tree Wells #1 and #2

Parameter	Palm Tree Well #1	Palm Tree Well #2
EC μS/cm	1980	2190
PH	8.05	7.90
Temp C^o	28.4	29.6
Dissolved O_2	2.15	1.82
BOD_5	86.8	N.D.
COD	125	N.D.
TOC	29.29	N.D.
NH_4 meq/l	0.021	0.03
NO_3 meq/l	0.77	0.795
HCO_3 meq/l	2.67	1.782
Cl meq/l	12.95	16.32
Ca meq/l	3.60	7.5
Mg meq/l	2.70	3.8
Na meq/l	13.14	11.50
K meq/l	0.14	0.2
SO_4 meq/l	2.97	2.916
CO_3 meq/l	-	0.00

Solid Waste

Domestic solid waste is collected from the security checkpoint at the Desert Highway Entrance in the north through to gate no. 4 of the Seaport, in addition to the airport. The collection is performed by the Common Services Council, which collects solid wastes from Aqaba and Quweira. The collection fees of 12 JD/household are included in electricity bills. There are currently 6 Mercedes waste disposal vehicles, 4 of which are Rota-press and 2 of which are compactors. Each vehicle makes 2 daily trips on the average. The total weight hauled per vehicle is estimated at 10 tons/day.

The existing disposal site is in the south near the industrial area in an upland wadi, east of the planned South Coast Tourism Zone. The round trip from Aqaba Town to this site is approximately 36 km. The disposal method at the site, soon to be abandoned, as it is almost full, consists of burning and burying [15]. The site is not properly maintained. Piles of discarded wastes line both sides of a winding one-kilometer road leading to the primary dumping area. Combustible garbage is burned in open fires, and non-combustibles remain exposed.

There is a newly proposed site of 100ha located to the south of the town on the back road. This site is located 18 km from the town center. The proposed area is sufficient for a population of 200,000. There are some current plans being investigated to determine the

feasibility of incinerating the waste, and producing fertilizers but these plans will depend on the availability of funding.

Waste composition in Aqaba follows the general trend in Jordan, with paper wastes forming 15%, plastic and glass 10%, iron and metals 5%, textiles and leather 4%, organic compounds 60%, and medical material 2%. Average solid waste generation is 439 kg/year/capita for the Aqaba Governorate, which exceeds the Jordanian average of 329 kg/year/capita. [13]

Solid waste generated by ship crews, ferry passengers, beach vacationers and local residents pose a constant, high-visibility environmental problem [17]. Plastics, bottles, paper and other garbage are scattered in the town, along roads, beaches, waters near shore reef, and particularly around ports [16]. No systematic recycling is currently in practice. [17] Used tires constitute a special environmental problem, since there are approximately 100,000 used tires lying about.

Wastewater

A sewerage network covers all of Aqaba except for some of the residential areas, parts of the Old Town and Shallalah neighborhoods, as well as other low-income areas [16]. The sewage of Aqaba Town is collected and pumped to the Aqaba Municipal Wastewater Treatment Plant (AMWWTP). According to regulations, the wastewater from parts of town that are not connected should be collected in septic tanks and transported to the wastewater treatment plant via septic tankers.

The AMWWTP is located in the Wadi Araba basin, 4km north of Aqaba Town, and 2km away from the Gulf. The plant relies on stabilization ponds and was put into operation in 1987. The inflow design capacity is 9000 m^3/day, with maximum BOD and TSS concentrations of 390 mg/l and 400 mg/l respectively. The treatment plant currently operates within its design capacity, with 70% efficiency.

The effluent quality does not match the design effluent quality. Jordanian Standards 893/1995 (Annex B, Table B-3) pertaining to the disposal of treated wastewater into streams, wadis and reservoirs as well as for groundwater recharge are also exceeded. The effluent quality, except for TSS, does however conform to the Jordanian standards 893/1995 pertaining to the use of treated wastewater for the irrigation of trees and fodder crops. Treated wastewater from the Aqaba plant is used in the irrigation of forest trees, trees used as wind buffers, palm trees and the Peace Park. The total quantity of water used for irrigation purposes in 1997 was approximately 1.0 MCM. [14]

The Water Authority of Jordan (WAJ) contracted Montgomery Watson Arabtech-Jardaneh (MWAJ) in performing the study and detailed design for the upgrade and expansion of the water and wastewater facilities in Aqaba for the Ministry of Water and Irrigation. According to the study conducted thus far, the treatment process of the new AMWWTP will include extended aeration activated sludge treatment, followed by polishing ponds as tertiary treatment. The study looked at three projection scenarios for Aqaba's population: without the freeport (low projection), with additional population from freeport (intermediate projection), and the total Aqaba population (high projection). Accordingly the capacity of the wastewater treatment plant will be increased from its current capacity of 9,000m^3/day to a maximum wastewater flow capacity of 24,000m^3/day, and BOD_5 loading of 10,600 kg/day. These values correspond to the high projection scenario for the year 2010 and the low projection scenario up to the year 2025. The basic design

parameters set out for the wastewater treatment plant upgrade and expansion are presented in Table 4.4.

Table 4.4: Aqaba Wastewater Design Flows and BOD_5 Loading.

Year	Wastewater Flow (m^3/day)		BOD_5 (kg/day)	
	High Projection	Low Projection	High Projection	Low Projection
2000	11,500	10,800	4,800	4,500
2005	16,800	12,900	7,000	5,400
2010	24,000	15,500	10,600	6,400
2015	34,200	18,600	14,200	7,700
2020	43,800	20,300	18,200	8,500
2025	50,400	22,600	21,000	9,400

Shaded values were used for the Aqaba WWTP project

4.2 Biological Environment

Marine Environment

The Gulf of Aqaba, one of two northern extensions of the Red Sea, is 180 km long, and ranges from 5 - 26 km wide with a maximum water depth of 800 meters. The Gulf is semi-enclosed and water circulation, which is caused mainly by evaporation rather than tidal action, is very slow. Based on preliminary observations in the Strait of Tiran, the residence time for shallow water in the Gulf is one to two years, and three years for deeper waters. Due to the long residence time, oil and other pollutants that enter the Gulf have a particularly detrimental effect since they are slow to disperse.

The Gulf's distinctive conditions: low siltation, high temperature, and high dissolved oxygen content -- result in a highly complex coral reef ecosystem. An estimated 50 percent of the shoreline is fringed with the 250 species of recorded corals, some of which are globally endangered such as the red and black corals. According to conservative accounts, 268 species of tropical and semi-tropical fish are found in the Gulf but the actual number could be as high as 1,000 species [1]. Most species find their habitats in reefs or sea grass beds. However, blacktip, hammerhead and whale sharks as well as pelagic fish species including skipjack, tuna and bonito are common in the Gulf's open waters.

Flora, Fauna, and Habitats

The Gulf of Aqaba's global importance stems from its geographical location, as it is the only inland connection between Africa and Eurasia. It serves as a bridge where many floral and faunal species are naturally transferred between east and west, north and south.

Designated as an 'Important Bird Area' by BirdLife International, the Aqaba region and the surrounding hills (an area of 130,000 ha) is a migratory bottleneck site for North-palearctic birds (with over 200 species recorded along this route) [18]. Aside from being a feeding area for non-breeding seabirds the area also holds a breeding-bird community representative of the Rift Valley. Migratory birds tend to cross the Rift Valley north of Aqaba up through Wadi Araba, as is indicated by relatively small maximum daily counts of raptors in the Aqaba region. Nevertheless, the total number of raptors passing over Aqaba exceeds 50,000 per season [19]. A list of Aqaba's birds and their respective status has been compiled in Annex E, Table E-1.

The study area falls within the Sudanian bio-geographical region. This region is characterized by temperatures as high as 48°C during the summer and very low rainfall. Accordingly, the vegetation is related to sub-tropical varieties. Species such as *Haloxylon persicum* and the locally threatened *Acacia tortolis* and *A. raddiana*, in addition to trees and shrubs typical of the Sudanese desert are found in the region. Most prominent are plants that can live in unfertile soil and dry climate. [10]

Aqaba has a high number of vipers, mainly of afro-typical origin e.g.: *Cerastes cerastes, Echis coloratus,* and *Walterinnesia aegyptia* that are mostly found in Wadi Araba. With the recent expansion of agriculture into Wadi Araba their numbers have increased [6]. As Aqaba lies in an arid region, its reptiles are rather diverse. Scorpion species reported in the Aqaba region include the very widespread *Leiurus quinquestriatus* (yellow in color) and *Androctonus crassicaud,* a desert adapted black scorpion considered as one of the most venomous species in the Middle East. *Androctonus amoreuxi* (yellow to dark brown) and *Buthacus leptochelys* have also been recorded. [7]

Mammals reported in the area include the red fox *Vulpes vulpes* (near villages), the IUCN red-listed Rupelli's Fox *V. rupellii* (found in the desert and sand dunes), and Hyena *Hyaena hyaena* (in rocky mountainous areas). Rodents of the area such as the lesser jerboa, spiny mouse, Libyan fat jird and the crested porcupine mainly inhabit the hammada deserts and sand dunes areas.

4.3 Socio-economic Environment

Population

1998 Department of Statistics publications estimate the Aqaba Governorate's population at 95,355 of which the majority reside within the boundaries of Aqaba town. The 1994 population Census estimated the population of Aqaba proper at approximately 70,000.

The estimated population projections for Aqaba, as depicted in Table 4.5, indicate that population will grow to 184,000 by year 2025 due to natural growth alone, or if paired with developmental activities may reach to approximately 355,000 [1]. The existing town may accommodate up to 145,000 persons, while an area of 3,500 hectares was identified for future development that together with Aqaba town will accommodate for up to 225,000 persons. Any additional growth will have to be accommodated for outside of the existing town boundaries.

Table 4.5: Aqaba Current and Projected Population

Year	Population Projections					
	Low Projections			High Projections		
	Base	Migration	Total	Base	Migration	Total
1998	73,438	-	73,438	73,438	-	73,438
2000	78,669	1,334	80,003	78,973	5,131	84,104
2005	93,434	5,506	98,940	94,705	26,626	121,331
2010	109,371	10,925	120,296	113,571	58,817	172,388
2015	124,955	17,588	142,542	136,195	107,715	243,910
2020	139,317	25,528	164,846	157,550	147,211	304,761
2025	151,568	34,684	186,252	172,673	182,550	355,222

Employment and Industry

Aqaba is considered one of the work-force attracting towns in Jordan. The percentage of active population in Aqaba Governorate, defined as persons 15 years and older who are either employed or not employed but are looking for employment whether they have or have not been previously employed, is 53% compared to 47% for the rest of Jordan. Table 4.6 shows the percentage of active population that is employed and unemployed in Jordan, Ma'an and Aqaba Governorates. [26, 27]

Among the males of Aqaba, the active population is estimated at 86%, and 12% for females. This may be explained by the adherence to a traditional image of a woman as a housewife, and the fact that most employment opportunities in Aqaba are available in work such as trucking, transportation, repair, loading, maintenance and port related activities that are generally regarded as more suitable for males.

The light industrial sector has not been well developed as of yet. Existing light industries are geared towards servicing of the transportation sector. An area north of Aqaba town is designated by the ARA revised Master Plan for light industrial uses. Among the uses planned for in this area designated for light industries are major workshop areas, Free Zone warehouses, truck maintenance and repair areas, brick and tile industries, and a Free Zone site (south of the selected site) currently used for storage of trucks.

Table 4.6: Percentage* of Active Employed and Unemployed Population in Jordan, Ma'an and Aqaba Governorates

Location	Economic Activity	% Males	% Females	% of Total
Kingdom	Not Active	23%	85%	53%
	Active	77%	15%	47%
	Employed	63%	9%	37%
	Unemployed	14%	6%	10%
	Total	100%	100%	100%
Ma'an Governorate	Not Active	19%	90%	51%
	Active	81%	10%	49%
	Employed	69%	9%	42%
	Unemployed	12%	1%	7%
	Total	100%	100%	100%
Aqaba Governorate	**Not Active**	**14%**	**88%**	**47%**
	Active	**86%**	**12%**	**53%**
	Employed	**75%**	**9%**	**46%**
	Unemployed	**11%**	**3%**	**7%**
	Total	**100%**	**100%**	**100%**

* Figures are obtained from a sample study and therefore only percentages are provided

Not Active Persons 15 years and older who are not employed and are not looking for employment

Active Persons 15 years and older who are either employed, or not employed but are looking for employment whether they have or have not been previously employed

Table 4.7 shows the distribution of employed persons in Aqaba Governorate according to sex, nationality, and economic activity.

Table 4.7: Distribution of Employed Persons in Aqaba Governorate who are 15 Years Old and Above

Economic Activity	Jordanian				Non-Jordanian		
	% of Males	% of Females	% by Sector	% By Sector Out of Total Workers	% of Males	% of Females	% By Sector
Transportation, Storage & Communication	34.2%	2.7%	35.1%	28.8%	18.8%	0.0%	18.8%
Public Administration, defense, and Social Security	13.2%	7.1%	14.2%	11.6%	1.5%	0.0%	1.5%
Mining and Quarrying	9.7%	0.0%	9.7%	8.0%	5.2%	0.0%	5.2%
Commerce, Motor vehicle repair	7.9%	2.5%	8.1%	6.6%	21.6%	1.4%	21.9%
Education	1.9%	72.1%	7.0%	5.7%	0.9%	50.0%	1.8%
Utilities Connection	4.4%	2.9%	4.6%	3.7%	0.0%	0.0%	0.0%
Manufacturing	4.4%	1.5%	4.4%	3.6%	9.7%	0.0%	9.7%
Health and Social Work	1.9%	47.3%	3.7%	3.0%	0.3%	50.0%	0.6%
Construction	3.3%	0.0%	3.3%	2.7%	18.8%	0.0%	18.8%
Agriculture, Hunting & Fishery	2.5%	2.6%	2.6%	2.1%	3.3%	0.0%	3.3%
Society & Social Services	2.4%	5.3%	2.5%	2.1%	4.9%	5.9%	5.2%
Restaurants and Hotels	2.4%	0.0%	2.4%	2.0%	8.2%	0.0%	8.2%
Financial Mediacy	0.9%	23.5%	1.1%	0.9%	0.9%	0.0%	0.9%
Real Estate, Rent & Commercial Projects Activities	0.7%	15.4%	0.9%	0.7%	2.7%	0.0%	2.7%
Unspecified	0.3%	0.0%	0.3%	0.3%	0.3%	0.0%	0.3%
Paid Housekeeping	0.0%	0.0%	0.0%	0.0%	0.0%	100%	0.9%
Non-Regional Organizations and Assemblies	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Total	90.3%	9.7%	100.0%	81.9%	97.3%	2.7%	100.0%

The largest employer in Aqaba is the transportation sector, which employs approximately 35% of the total workforce in Aqaba: males form 97% and females approximately 3% of the total employees within the transportation sector. The manufacturing sector in Aqaba employs 4.4% of the total Jordanian employees in Aqaba, 98.5% of which are males, and 1.5% are females. The highest percentage of women is employed by the education sector (72.1%), followed by the Health and Social Work Sector (47.3%) and the financial sector with 23.5% females.

The industrial sector in Aqaba consists mainly of heavy industries that are located in the South Industrial Zone (Figure 4.2) on the borders with Saudi Arabia and include: Jordan Phosphate Mining Company; Nippon Jordan Fertilizer Plant; Arab Potash Company; Jordan Cement Factories; and the Aqaba Thermal Power Plant among others. These industries have established in Aqaba due to the proximity of raw materials and available port services.

Land Use and Development Plans

In the immediate area, land use is restricted to an airport expansion zone around the airport that extends to the western border of the selected site, the existing free zone and proposed treated wastewater effluent lagoon to the south and brick factories to the east (Figure 4.2). In addition, there is evidence of nomadic grazing (camel and goats) in and around the selected site. Bedouins are also presumed to live in the area however; their nomadic life-style never keeps them in one area for a significant period of time.

The TSG revised the ARA 1995 - 2005 Master Plan, the latest adopted by the ARA, designates the land north of Aqaba town (including the selected site) as a Light Industrial Zone. According to the Master Plan the types of activities that will be permitted in this northern industrial zone include those proposed for in this development.

Therefore, the establishment of the AIIE falls within the Master Plan specifications and is not expected to interfere with any other planned sectors' activities such as transportation, tourism and residential expansion.

According to the ARA revised land use Master Plan the total area designated for the northern light industrial zone is 500 ha. The Proposed New Airport Highway will constitute a natural buffer zone between the residential and commercial developments of Aqaba town and the industrial zone. Figure 4.2 depicts the land use plans specified in the latest Aqaba Master Plan adopted by the ARA.

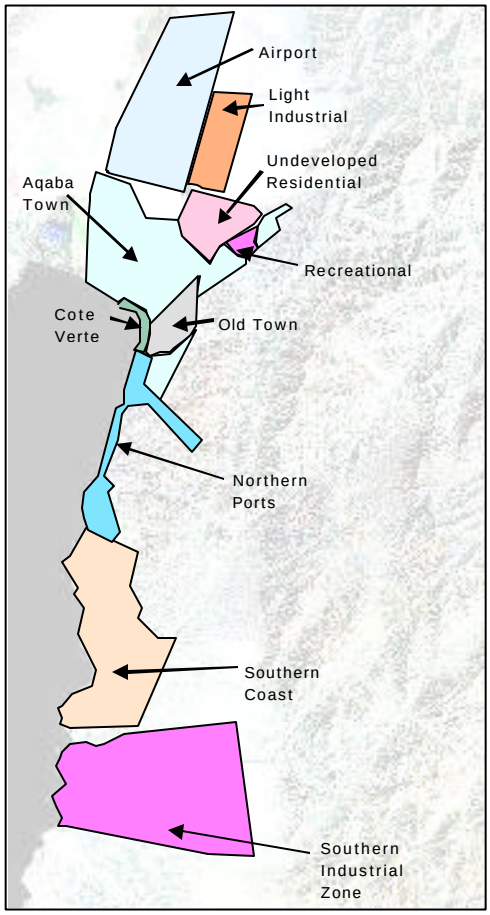
At present there are numerous development plans that are proposed for the town of Aqaba, both within the Peace Process context, and within the national context to economically develop Jordan's southern regions, and make better use of Jordan's only coastal area. Many of these plans were revised and discussed in the TSG Aqaba Freeport / Special Economic Zone Feasibility Study and Implementation Plan (1999).

The town is expected to develop as a tourist resort, with projects suggested such as increasing the number of 4 and 5 star hotel rooms, a golf course, horse riding course, improved tourist infrastructure, services, and entertainment facilities. Furthermore, landscaping projects that are planned for Aqaba intend to increase the green areas in the town and its vicinity using treated wastewater from the AMWWTP.

Economically, Aqaba has already been declared as a Special Economic Zone, with the possibility of adding the status of a Freeport Zone. Within this context the Port may be re-located to the Southern Industrial Zone in addition to expected expansion in industries in this Zone.

Within the context of the Peace Process a Peace Park has been established for the protection of marine habitat that extends to include some of the hinterland mountains, and in the future to include a multi-lateral research center. A Red Sea - Dead Sea Canal may be also constructed as a result of trilateral agreements to control Dead Sea water levels and generate electricity for desalination of seawater and brackish water to be used for the economic development in the region.

Figure 4.2: Aqaba Land Use Master Plan



Tourism

In 1998, Aqaba had 4081 classified and unclassified hotel beds. Tourist amenities and attractions are not yet well developed, with few restaurants, pubs, nightclubs, and other recreational centers. Sport activities in Aqaba mainly include water sports: snorkling, diving, and limited water sports, in addition to tennis courts at some hotels. The museums in Aqaba include the Aqaba Marine Museum located in the Marine Science Station, which displays many fish and coral species and an archaeological museum.

On average, of the total Jordanian arrivals and departures during 1994 through 1998, 13.5% and 14.8% were through Aqaba respectively. The departures and arrivals for Jordan and their breakdown in Aqaba according to entry points are depicted in Table 4.8 and Table 4.9.

Table 4.8: Departures from Jordan through Aqaba Departure Points

Point of Departure	1994	1995	1996	1997	1998
Aqaba Airport	35.0	36.5	33.4	48.0	56.5
Aqaba Port	671.8	567.4	530.5	437.4	337.3
Wadi Araba Entry Point	19.4	89.4	110.4	100.7	81.7
Total Aqaba	726.2	693.3	674.3	586.1	475.5
% of Total	17.6%	16.0%	16.1%	14.3%	10.2%
Total (Jordan)	4128.6	4339.0	4175.4	4112.2	4646.7

Table 4.9: Arrivals to Jordan through Aqaba Entry Points

Point of Departure	1994	1995	1996	1997	1998
Aqaba Airport	10.0	6.0	3.0	17.0	31.0
Aqaba Port	658.0	573.0	549.0	416.0	324.0
Wadi Araba Entry Point	21.0	78.0	99.0	93.0	75.0
Total Aqaba	689.0	657.0	651.0	526.0	430.0
% of Total	15.8%	15.0%	15.3%	12.3%	9.4%
Total (Jordan)	4367.0	4391.0	4266.0	4266.0	4586.0

Aesthetics

Aqaba town is still undergoing a transitional stage in terms of construction and other developmental activities. These are most evident at the entrance of the town via the Desert Highway. Since Aqaba is still in its early stage of development, any development should consider aesthetics as an important factor that could have a cumulative effect on the economic potential of Aqaba. A lack of attention to aesthetics results in the unsightly atmosphere present at the Desert Highway entrance to Aqaba and the view from the shore disrupted by phosphate ship loading.

The selected site is located at the entrance point to Aqaba via the airport and the Dead Sea Road. Provided clear visibility, Aqaba's visitors encounter an expanse of desert that is bounded by a huge ridge of mountains on either side forming a surrealistic background of shapes and colors. This backdrop, when entering from the north is somewhat interrupted only by the presence of the airport on the western side of the road. The existing free zone area located further south of the selected site used for the storage of trucks and heavy machinery is also considered unsightly by most.

Archaeology

As a general rule, sites in Jordan are rare and sporadic in dryer desert areas; most settlements and other archaeological sites are found in areas with fresh water and fertile soils. Aqaba however, is an exception to this rule and has some significant sites since it is on the sea where abundance in seafood attracted various civilizations. Some of the wadis near Aqaba, along with a few shallow water wells, most likely provided drinking water.

The Jordanian Antiquities Data Base and Information System (JADIS) does not indicate the presence of any archaeological sites at the selected site under the Proposed Action or in close vicinity to the construction buffer zone boundaries (+/-25m). The only recorded site is Tell Magass that dates back to year 3500BC located 415m south of the selected site. This site however, will not be affected by construction and operation activities of the Proposed Action since its has been sealed off and can be easily avoided.

The EA team conducted a reconnaissance survey of the project site to ensure that the project area does not contain any archaeological artifacts. Furthermore, a team from the Department of Antiquities in Aqaba, consisting of 6 persons under the supervision of the Department's Archaeological Chief Inspector, performed a 2-day archaeological reconnaissance survey of the selected site. The following are the official findings, observations and conclusions of the survey conducted:

- The selected site under the Proposed Action does not contain any archaeological sites;
- Tell Magass archaeological site, dating back to year 3500BC, is located 415m south-west of the selected site, and will not be affected by project activities in and immediately around the site;
- Parts of the selected site have already been disturbed by activities that include quarrying;
- Several surface floodwater courses lead to soil erosion and deposition that change the topography of the area and could have damaged site that used to exist; and
- Relatively recent graves belonging to local Bedouins are scattered randomly throughout the selected site.

5. Environmental Consequences

This chapter presents a discussion of the environmental consequences that may result during construction and operation of the project. Individual components of the project are not discussed separately; rather, the project is discussed as a whole in terms of its expected consequences under the environmental issues as determined during Scoping. In addition to the environmental consequences, mitigation measures are also provided.

The focus of the discussion is on the construction stage of the proposed development. The operational stage is discussed more generally in terms of consequences that are likely to be common to all investors operating within the Estate. The exact types of industries that will be operating within the Estate are not yet known and therefore it is not possible to identify and assess operational impacts at a greater level of detail.

5.1 Socio-Economic Conditions

Employment & Economy

The Project is expected to have a positive impact on employment opportunities during construction and operation stages, due to creation of new employment opportunities. The direct employment created during construction will be short-term, however operational employment benefits are long-term. For example, in addition to the direct employment of construction workers, construction related services and materials suppliers would also benefit.

According to the Aqaba Town Master Plan Review prepared for the ARA, for every 100 employment opportunities created in the manufacturing/light industrial sector, 56 employment opportunities are created in the services sector. Women's role in the employment sector may increase due to the light nature of industries expected to establish.

The rate of increase in employment opportunities depends on the Development Phasing that will actually occur. If QIZ status demands are realized, then by the end of Phase I approximately 1888 direct employment opportunities would be created in addition to 1057 employment opportunities in the services sector. By the end of Phase II, approximately 4964 direct and 2780 indirect employment opportunities would be created, and by the end of Phase III approximately 11700 direct and 6552 indirect work opportunities are expected to be created in Aqaba.

The impacts on employment are not limited to Aqaba Town, as workers are likely to come from other parts of Jordan, especially from the southern Governorates. Other parts of the country may also develop primary industries or produce some of the inputs or raw materials required by the Proposed Estate's investors in addition to provision of marketing, transportation, and financial services to the Proposed Estate.

In addition to the direct and indirect employment opportunities that the proposed project is expected to induce, the project is also expected to positively impact land value, place a demand on public services, education and recreational activities in Aqaba. Therefore, the influx of workers and creation of local employment opportunities has several positive economic spin-offs.

Table 5.1 shows that there are more direct and indirect employment opportunities created under the Freeport/QIZ scenario than under the status quo.

Table 5.1: Employment Opportunities Created

Development Phase	Status Quo Scenario			Freeport/QIZ Scenario		
	I	II	III	I	II	III
Years	0 - 5	5 – 10	10 – 20	0 - 5	5 - 10	10 – 20
Direct Employment	688	1,204	1,410	1,888	4,964	11,700
Indirect Employment	385	674	790	1,057	2,780	6,552
Total	1,073	1,878	2,200	2,945	7,744	18,252

Recommended Actions

In order to increase the expected positive impact of the project on employment opportunities, economic conditions and on community development, priority should be given to local residents of Aqaba including Bedouins and women. Jordanians from the southern governorates should also be given priority.

Health and Safety

During the construction stage of the project, health and safety may be affected by increased construction related traffic such as the movements of heavy machinery and construction materials, equipment and labor transportation. The risks of traffic related accidents and other construction accidents are more or less limited to the construction site and areas where the project's construction related traffic is high (at and around the selected site). Construction related traffic is expected to pass through Aqaba Town, however not in significant volumes through residential areas.

Occupational (worker) health and safety can be affected by prolonged exposure to sun, heat, noise and dust, in addition to solid waste and wastewater disposal possibly with long-term effects. Risks of accidents due to operation of heavy machinery, transportation, as well as encounters with venomous reptiles and invertebrates are likely to be high.

Public health and safety may also be affected through increased dust and noise generation from transportation on unpaved roads, excavations, earthworks and the operation of heavy machinery. The negative impact of the construction activities on health and safety associated with dust and noise generation (see section 5.2) are insignificant due to the distance between the proposed site and Aqaba town. The airport would be the only substantial recipient of such impacts. However, since an airport is a high-level noise generator in itself, and since it is accustomed to high levels of background dust, this impact can be considered insignificant. Furthermore, dominant wind directions would not likely send dust from the Estate towards the airport.

During the operational stage, negative impacts on public health are considered insignificant assuming the environmentally friendly nature of industries expected to establish. Off-site transportation during the operational stage is also considered insignificant in terms of its potential impact on traffic accidents due to the relatively low (relative to other operations) operational traffic volumes expected.

Worker safety however, will still be a concern depending on the nature of work and conditions of the working environments. High in-plant temperatures could directly result in unsafe work practices and low productivity, factors that may contribute to excessive manufacturing costs. Irrigation of landscaping with treated wastewater may also lead to an increase in health risks if not appropriately monitored and managed.

Recommended Actions

Prior to construction, workers should be properly selected, trained, and made aware of the various occupational health hazards and risks. During construction, protective equipment should be provided such as construction boots and helmets. Potable water should be easily accessible and electrolyte rich liquids or foods should be distributed during the summer (hot) months to prevent electrolytic disbalance. In addition, earplugs, earmuffs, and vibration-reducing gloves should be provided where needed depending on the type of work. There should be clauses in the construction tender documents for these measures to be implemented.

Appropriate on-site traffic management should be implemented. Routes used by heavy machinery should be specified and workers should be informed of these routes to avoid accidents. If any work is to be performed during the night or in conditions of poor visibility, sufficient lighting and fluorescent marked clothing should be provided. The above measures should be included in the contract clauses of the construction contractor.

During operation, workers should also be trained in proper health and safety procedures. Such training will likely be the responsibility of the investors, however, the Estate's operator should ensure that it is carried out. Investors should also provide appropriate sanitary conditions, potable water, and protective equipment depending on the type of work. Proper irrigation techniques should be utilized to minimize the potential transmission of air borne diseases associated with gray water irrigation. Appropriate solid waste storage, collection and disposal can minimize vector (disease carrying organisms) breeding.

Trees should be planted wherever possible around building to increase the shaded area and aiding in maintaining cooler temperatures inside buildings. Another benefit of planting shade trees is proven reductions in air conditioning electricity bills. Temperatures inside buildings should be regularly monitored, especially during the summer, and working shifts should be designated according to Jordanian standards 525/1987 (Annex D).

Aesthetics

The aesthetics of the project area are considered important during construction and operation since the selected site is located at two entrance points (Dead Sea Road and Airport) to Aqaba and constitutes first impressions of Aqaba. During the construction stage the visual intrusions created by vehicles and heavy machinery carrying construction materials, dust generation and solid waste may impact the aesthetics of the area. These impacts during construction, however, are short lived.

During operation, the estate may impact the aesthetics of the area if solid waste collection and disposal is not properly controlled or if the estate presents a poor facade. The built Estate will hinder the view of the mountain ridges and prevent Bedouins herding their animals, which may be considered as a tourist attraction and a part of the whole aesthetics of the area.

It is important that the aesthetics of the estate somewhat compensate for the loss in the existing (natural) visual environment. The proposed green-belt perimeter around the estate is one such compensation. The project's impact on the aesthetics in the project area will be permanent after completion of construction activities.

Recommended Actions

During the detailed design stage of the project, the height of buildings and fencing should not obstruct the view of the mountains. All solid waste should be collected and disposed of regularly and in a timely manner to prevent the dispersion of lighter solid wastes and generation of undesirable odors. To the extent possible, Contractors should ensure that soil cover and topography is restored to the way it was prior to any construction related activities. Clauses ensuring the above measures should be included in the construction tender documents.

During operation, the outer boundary of the Proposed Estate should be kept clean and tidy at all times. The outer wall should be surrounded with at least 2 rows of trees to decrease the visual intrusion of the installation buildings. The perimeter wall and installations that are visible from the Dead Sea Road and airport should be well maintained to prevent the shabby appearance that is usually associated with industrial estates. The colors chosen should be compatible with the surrounding environment (white or light pastels). No solid wastes or unused/broken down machinery, cargo boxes should be visible from outside of the Estate.

Archaeology

Although no archaeological findings have been established in the proposed site, the risk of still unearthing historic artifacts or sites during construction stands. The risk of their unintentional damage or destruction or deliberate confiscation during construction poses an irreversible negative impact, the extent of which depends on the significance of the findings. No impacts on archaeology are expected during operation.

Recommended Actions

The construction contract should make the Contractor responsible in ensuring that workers are alerted to the possibility of unearthing archaeological artifacts and should be instructed to stop activity in the vicinity of the suspected artifacts. The Contractor should also alert the Department of Antiquities in Aqaba, whose representative would be financed by the Project to inspect the potential findings and act in accordance with the Law of Antiquities No. 21/1988.

Traffic

As described under environmental consequences related to Health and Safety, traffic problems are expected to be more significant during the construction stage. Construction traffic may interfere with other traffic, although relatively limited in volume, that uses the existing Dead Sea Road. Crossing of roads for the purpose of construction of utilities' lines may temporarily disrupt traffic.

Operational traffic impacts will be limited, as operation traffic volumes are not expected to be significant. The proposed land use planning and transportation infrastructure expected

to serve Aqaba and the proposed project's area will also limit the impacts related to traffic during the operational stage.

Recommended Actions

Road safety should be maximized through proper signage and alerting drivers to the possible movement of heavy machinery especially on the Dead Sea Road. Standards concerning maximum allowed speed limits for vehicles transporting construction materials should be enforced according to vehicle type.

In order to avoid congestion and traffic disruptions, appropriate timing of transportation activities, use of detours, and co-ordination with the Aqaba traffic control department should be established if seen necessary. These measures should be clearly specified in the construction tender documents and the Contractor's contract.

5.2 Atmospheric Resources

Dust

Impact of dust generated during construction on the nearby airport activities will be slight and short-term as wind directions are predominantly northerly. The airport runways are also equipped with an Instrumental Landing System (ILS), which would minimize the hazards of reduced visibility on aviation traffic. Although town inhabitants and tourists reside downwind of the selected site, dust generated from construction activities would be short-lived and potentially insignificant in comparison to the background dust levels that both the town and airport are accustomed to.

Insignificant negative impacts from dust are expected during the operational stage. Moreover, the proposed green belt around the Estate may have a positive impact on lowering the levels of dust traveling southwards from the Wadi Araba desert towards Aqaba Town.

Recommended Actions

Avoid excavations and earthworks during windy conditions. Provision of proper road covering can minimize dust from dirt tracks used by vehicles and heavy machinery on-site and on access routes. During operation, proper maintenance and care of the green belt surrounding the Estate would prevent dust from blowing into the Estate and form a barrier to dust blowing towards Aqaba.

Emissions

Exhaust emissions from construction-related vehicles as well as from the operation of heavy machinery may increase the levels of exhaust gases and particulate concentrations in the vicinity of the construction area and may consequently affect the town downwind for short periods of time. Relatively continuous (offshore and onshore) winds also mitigate this impact since the air over Aqaba does not remain stagnant.

Industrial emissions expected from the Proposed Estate are not considered significant, hence no significant negative impacts are expected to follow from air emissions during operation. Environmental operating and investor permitting procedures must not allow for

air emissions that would potentially reach and affect Aqaba Town. Estate-related transportation however would add to the vehicle emissions already experienced in Aqaba.

Recommended Actions

During construction, all machinery and vehicles should be properly maintained, oiled and inspected to prevent excessive emission of exhaust gases. During operation, standard operating procedures (SOP) and permitting procedures should be designed and adhered to, that would prevent industries with air emissions from establishing at the Estate. Monitoring and enforcement programs should be designed to ensure that stack emission standards are adhered to if stacks are to be allowed in the first place.

Noise

As described under environmental consequences on Aesthetics and Health and Safety, impacts from the proposed project related to noise are considered insignificant. This lack of significance is based on the distance of the selected site from residential areas and proximity to the airport that is already associated with high noise levels. No mitigation measures are therefore required to minimize the impacts associated with elevated noise levels except for those pertaining to occupational health and safety.

5.3 Natural Environment

Marine Ecology and Coral Reefs

The project is not expected to directly affect the marine environment during construction. A cumulative and indirect long-term impact may result due to an increase in port related transportation as a result of operation of the Proposed Estate. This indirect impact however, may be considered insignificant in light of the relatively small contribution the Proposed Estate will likely have on shipping traffic and associated impacts on the marine environment.

Soil Disturbance and Contamination

Earthworks that include excavations, vegetation and boulders clearing, transportation and operation of heavy machinery during construction will affect soil physical properties. Generally the result would be a loss in soil structure. This, in turn, may result in higher dust generation (see section 5.2), an alteration of surface water runoff characteristics and hence an increase in wind and water erosion. These impacts are expected to be short-lived and are considered reversible especially if appropriate soil reclamation and rehabilitation is carried out after construction is complete.

During both the construction and operational stages of the project soils may be exposed to oils, lubricants, chemicals and fuels associated with vehicle and machinery maintenance and chemicals and fuels storage. Unplanned events and accidental spills as a result of improper handling of such materials in addition to solid waste and wastewater could also lead to soil contamination. Such impacts are likely to be long-term in nature and could also potentially contaminate groundwater and surface water flows.

Recommended Actions

Minimize access routes and vehicle and heavy machinery routes through the specification and designation of only certain routes for use. In addition to help regulating construction traffic this would also decrease soil disturbance associated with vehicle movement. Following the completion of construction the Contractor should properly reinstate soil condition to the extent possible. Maintain and service equipment, machinery and vehicles at designated areas to minimize potential soil contamination. Following construction, contaminated soil should be reclaimed or taken to the municipal landfill.

Fauna, Flora, and Habitats

Although the habitats in the selected site are already disturbed, the construction stage will non-the-less increase the impacts of disturbance, as clearance of vegetation will lead to complete loss of habitats. Species of concern identified on the site are Acacia trees (Annex E, Table E-5), classified as locally threatened. It is worthwhile to note that even though these species and their related habitats are well represented along Southern Wadi Araba, the project would be contributing to the cumulative threat these ecosystems are exposed to on the Jordanian scale. *Caralluma sinaica*, an IUCN red-listed species, has also been recorded in Aqaba but its presence in the proposed site has not been verified.

Due to the proximity and existing high disturbance of the airport, the impact of the construction works on avifaunal life will be insignificant and short-lived. The nearby AMWWTP is more of an attraction to birds and provides a more suitable alternative habitat. Illegal hunting by workers and increased road kills, both of which may occur during construction and operation, are further threats to the terrestrial ecology of the site and surrounding area.

Recommended Actions

Workers should be alerted to the significance of fauna and avifauna and hunting must be strictly forbidden during construction and operation. Landscaping should incorporate flora that is indigenous to the area. Integrated pest management should be used to overcome any potential pest problems as opposed to pesticides. This involves an integrated preventative approach where firstly the causes of the infestation (inappropriate storage of food substances and poor solid waste collection, storage and disposal, etc.) are first eliminated. Then if seen necessary, deterrents or trapping should be used, and only as a last resort should pesticides be utilized and in as little quantity as possible. If pesticides are used, the estate operator should ensure appropriate storage, handling and disposal.

Groundwater Resources

Adverse impacts of the project may include the direct risk of groundwater contamination due to hazardous materials' spills or leaks (chemicals, fuels and lubricants, etc.) both during the construction and operational stages. Inappropriate handling of solid and liquid wastes in addition to the associated risks of unplanned events and spills could also lead to groundwater contamination. The groundwater in the area is expected to be relatively shallow and the area is considered a groundwater recharge zone (Refer to Section 4.1). When also considering the scarcity of fresh water resource in the area, groundwater quality protection is a major concern. In the long run, even this Proposed Estate may need

to utilize the groundwater present below the area and therefore its protection must be seriously considered.

As mentioned in Section 5.3, groundwater contamination may also result indirectly from the project as a result of solid waste landfill leachate if the new landfill is not appropriately designed and operated. This is an indirect and long-termed impact resulting from the Estate's added pressure on solid waste collection and disposal. Treated wastewater re-use for irrigation purposes is not expected to significantly impact groundwater quality assuming that it complies with appropriate standards for irrigation reuse (Annex B).

Recommended Actions

During the construction stage of the Estate the Contract should contain clauses ensuring that the Contractor collects any wastewater and spills in the site, and ensure that materials are properly handled and stored. During the Operation stage of the Estate proper the Estate operator must ensure that investors properly handle and store materials on site, and that industrial wastewater is properly treated and disposed of.

Floodwater

As described under Soil Disturbance and Contamination and in Section 3 under Wastewater and Surface Water Run-off, the project is expected to cause some alterations in natural floodwater courses. However, the selected site was chosen while considering the effect that floodwaters may have on the project.

With the incorporation of surface water drainage protection ditches this impact of the environment on the project (flooding) should be insignificant. The impact on surface water runoff will be limited to alterations in watercourses and associated soil erosion and will only significantly occur in the rare event of heavy flooding. Nevertheless, appropriate on-site and peripheral surface drainage systems should be designed and constructed.

Seismic Risk

Similar to floodwater, this issue pertains to an effect of the environment on the project. Given the history of the area, earthquakes and strong tremors should not be ruled out. All buildings, roads, utility connections and networks should be designed while taking into consideration the seismic risks. Appropriate design and construction can minimize the safety hazard and damage potential associated with a potential seismic event.

5.4 Other Issues

Disposal of Wastewater

Wastewater generated during construction would mainly result from sanitation and domestic type usage of the laborers and potentially some other construction-related water use. As described earlier in section 5.1, improper handling of such wastewater may pose an occupational health hazard. Fuel and hazardous material leaks or spills (oils, lubricants, solvents, etc.) may cause long-term negative impacts on workers' health, surrounding habitats, as well as threaten to contaminate soils and groundwater/surface waters.

Wastewater generated from the Estate during operation is expected to adhere to Jordanian standards (Annex B) and will be appropriately collected and conveyed to the existing AMWWTP. Therefore wastewater should not pose any impacts similar to those described for construction except for in the event of accidents and unplanned events. Industrial wastewater that does not meet standards should be treated and disposed off by individual industries.

The capacity of the effluent conveyance pipe will be designed to accommodate for the maximum sewage flows expected at full development of the Proposed Estate. Running below the conveyance capacity during the initial phases may lead to anaerobic conditions within the pipeline and may jeopardize the operation of the AMWWTP. Ensuring that the quality and quantity of wastewater conveyed to the AMWWTP does not jeopardize its operations is essential to maintaining an insignificant impact associated with operational wastewater.

The Estate will be using treated wastewater for irrigation purposes. The positive impacts of such wastewater reuse would be the alleviation of stress on municipal water supplies and efficient disposal of treated wastewater effluent. This wastewater reuse, however, should also comply with Jordanian Standards (Annex B) and safe irrigation practices with treated wastewater.

Recommended Actions

During the construction stage, the Contractor should ensure that liquid wastes are properly stored, collected and disposed preventing or surface or groundwater contamination. During operation, wastewater quality released from industries should conform to the Jordanian Regulations Governing Discharge of Industrial & Commercial Wastewater Into the Sanitary Sewer System (Annex B, Table B-1).

Appropriate screening and permitting procedures should be designed to ensure that industries that generate wastewater not in compliance with Jordanian standards (Annex B, Table B-1) are not permitted to establish in the Estate. Furthermore, a monitoring program should be designed to ensure that industries conform to these standards minimizing the potential for jeopardizing the treatment operations at the AMWWTP. No wastewater tankers should be allowed to pump wastewater out of the Estate. Their entry into the estate should be prohibited unless clear reasons are provided and permits are obtained from the Estate operator to avoid illegal discharges of wastewater that does not conform to standards (Annex B).

Disposal of Solid Wastes

Improper handling and disposal of construction waste (excavates and excess construction materials, etc.) could lead to long-term negative impacts on both the Estate area and Aqaba Town. These would largely be associated with reduced aesthetic values, and higher sediment loads in surface run-off.

Being a light industrial estate, no hazardous wastes are expected to be generated during operation. Any hazardous wastes will need to be treated and disposed of separately depending on the composition. Aqaba's existing municipal solid-waste dump is nearing full capacity. A newly proposed solid waste dump will become operational in the near future. Domestic-type solid wastes (mainly packaging related wastes) generated from the

Proposed Estate will be disposed of in this new landfill. Unfortunately, there is no solid waste recycling being practiced in Aqaba.

More advanced waste treatment and disposal practices at the new dump should minimize the indirect impacts from the disposal of solid waste generated at the Proposed Estate. Collection and transportation of the solid wastes generated however may result in occasional littering along the routes taken. It will be up to who ever is designated or contracted to collect and dispose of solid wastes and the agency responsible for their monitoring (currently the ARA) to ensure appropriate collection and disposal practices. It would be up to the Proposed Estate's operating agency to ensure that solid wastes collected do not include any hazardous materials.

Recommended Actions

During the construction stage of the project, the Contractor should be held responsible for the proper disposal of construction related solid wastes. During operation, waste minimization, reselling of solid wastes to other industries in the area and separation of recyclable materials should be encouraged to ease the introduction of recycling programs if seen feasible in the future.

Water Consumption

The Aqaba Water Authority will meet the water requirements of the Proposed Estate. This exerts additional pressure on the municipal water supplies of Aqaba. The extent of this added pressure depends on the availability of supplies and demands that may emerge in Aqaba in the future. This applies to both the construction and operation stages however, much more significantly on the latter especially with full development of all three developmental phases.

It is the policy of the Water Authority of Jordan that a maximum of 17.5 MCM/year is allocated to Aqaba, and therefore, with increased municipal demand for water resulting from population growth, water allocation to industries will be decreased, and industries will be required to seek alternative water sources to compensate for deficits in water supplies.

Reuse of treated wastewater for landscaping purposes is expected to significantly alleviate the Estate's demand for freshwater supplies from the municipal supply. Similarly water conservation and reuse should be practiced wherever appropriate.

Recommended Mitigation Measures

The main mitigation related to water consumption during the operation stage of the project include proper metering of water consumption, maintenance of networks, giving priority to low water consuming industries, and installing water saving devices such as water saving taps and low volume toilet flushing tanks. Furthermore, treated wastewater should be used as planned, for landscaping and irrigation available from the planned AMWWTP treated wastewater storage reservoir south of the Estate.

Demand projections of fresh water requirements should be regularly updated and compared to the Water Authority's supply capabilities to appropriately plan for alternative sources of water in the event of deficits.

6. Recommended Mitigation Measures & Environmental Monitoring

Appropriate design and implementation of Environmental Permitting and Operating Procedures in addition to related policy is essential in mitigation of all impacts. In addition to the mitigation measures described in the previous chapter, monitoring and contingency plans should be detailed.

This section presents a summary of the mitigation measures proposed for the detailed design, construction, and operation stages of the project. A brief summary of the recommended mitigation measures is given; more detailed discussions related to the proposed measures and the impacts being mitigated are found under each individual environmental issue in Chapter 5.

6.1 Recommended Mitigation Measures for Design and Construction

During the design and contract preparation stage, the construction contractor should be made responsible to ensure that the mitigation measures outlined below during the construction stage are implemented and properly followed unless otherwise stated. These measures should be part of the Contracted obligations.

Employment and Economy

- The Contractor, Estate Operator, and individual industries should give priority for employment to local residents of Aqaba including Bedouins and women, in addition to Jordanians from the southern governorates where possible.

Health and Safety

- Perform appropriate selection and training of employees prior to commencement of construction;
- Provide and distribute protective equipment, potable water, and in the summer electrolyte rich drinks; and
- Implement appropriate construction traffic management.

Aesthetics

- During the detailed design stage, an appropriate height for buildings and perimeter fencing should be chosen so as not to obstruct the views from main roads and the airport;
- Collect and dispose of solid waste regularly and in a timely manner; and
- To the extent possible and where applicable, soil cover and topography should be restored and rehabilitated to their pre-construction conditions.

Archaeology

- Co-ordinate with Department of Antiquities (DoA) for a representative of the department to be present during site excavations;
- Alert workers to the possibility of unearthing archaeological sites or artifacts and inform them of appropriate procedures (below); and

- Stop activity in the vicinity of the suspected artifacts until a member from the DoA in Aqaba inspects the potential findings in accordance with the Law of Antiquities No. 21/1988.

Traffic

- Use proper signage and alert drivers to the potential movement of heavy machinery;
- Appropriately set and enforce maximum allowable speed limits for construction related traffic; and
- Coordinate with the Aqaba Traffic Control Department for appropriate timing of transportation activities and detour requirements.

Dust

- Avoid excavations and earthworks during windy conditions; and
- Provide proper road coverings on-site and on access routes.

Emissions

- Properly maintain and regularly inspect all machinery and vehicles.

Soil Disturbance and Contamination

- Specify and designate only certain routes for use;
- Implement mitigation measures related to the disposal of solid wastes and wastewater;
- Properly reinstate soil condition to the extent possible following construction;
- Maintain and service equipment, machinery and vehicles at designated areas to minimize potential soil contamination; and
- Reclaim or remove and appropriately dispose of contaminated soil at the municipal landfill.

Disposal of Wastewater

- Ensure that liquid wastes are properly stored, collected, and disposed of.

Disposal of Solid Wastes

- Collect and dispose of all solid waste regularly and in a timely manner.

Flora, Fauna and Habitats

- The Contractor should alert workers to the significance of fauna and avifauna; and
- The Contractor should strictly prohibit any hunting.

6.2 Recommended Mitigation Measures for Operation

During the operation stage, the mitigation measures outlined below should be implemented by the individual investors and the Estate Operator, who should also be held responsible for ensuring that individual investors are conforming to the proposed mitigation measures, unless otherwise stated.

Employment and Economy

- The Contractor, Estate Operator, and individual industries should give priority for employment to local residents of Aqaba including Bedouins and women, in addition to Jordanians from the southern governorates where possible.

Health and Safety

- Train workers on appropriate health and safety procedures and according to their individual tasks;
- Provide appropriate sanitary conditions, potable water, and protective equipment according to the type of work performed;
- Appropriately store, collect, and dispose of solid wastes;
- Perform regular monitoring of indoor temperatures during summer;
- Trees for shade and cooling effect should be planted around all buildings where possible; and
- Use proper landscaping irrigation techniques for use of treated wastewater.

Aesthetics

- Keep the outer boundary of the Proposed Estate clean and tidy at all times;
- Properly dispose of solid waste not allowing them to accumulate in or around the Estate;
- Two rows of trees should be planted (as incorporated in the initial design) around the perimeter of the Estate;
- Ensure that the perimeter and any installations visible from the Dead Sea Road and the Airport are properly maintained; and
- Use colors that are compatible with the surrounding environment such as white or light pastels for exterior surfaces.

Dust

- Ensure proper maintenance of the green belt around the Estate.

Emissions

- Develop and implement standard operating and permitting procedures that prevent industries with air emissions (if any at all) from establishing within the Estate; and
- Monitor and enforce stack emission standards if stacks are to be allowed in the first place.

Flora, Fauna, and Habitats

- Incorporate indigenous flora into the landscaping scheme;
- Prohibit any hunting or trapping of wildlife;
- The Estate Operator, and individual investors should alert workers to the significance of fauna and avifauna;
- Implement mitigation measures related to solid waste disposal
- Use integrated pest management by first eliminating potential causes of infestation, followed by use of deterrents or trapping, and as a last resort use minimal quantities of pesticides; and

- Ensure appropriate storage, handling and disposal of any pesticides.

Groundwater Resources

- Collect of any wastewater and spills in the site
- Proper handling and storage on site
- Proper treatment and disposal of any industrial wastewater
- Seek the co-operation of the Water Authority in Aqaba for water quality analysis and water use planning.

Disposal of Wastewater

- Design appropriate industrial screening, permitting and operating procedures;
- Ensure that wastewater quality collected from industries conforms to the Jordanian Regulations Governing Discharge of Industrial & Commercial Wastewater into the Sanitary Sewer System (Annex B, Table B-1);
- Ensure that liquid wastes are properly stored, collected, and disposed of.
- Design a wastewater monitoring program that ensures industries conform to discharge standards; and
- Prohibit, within reason, wastewater tankers from entering the Estate.

Disposal of Solid Wastes

- Collect and dispose of all solid waste regularly and in a timely manner.
- The Estate operator and individual industries should work together towards waste minimization, reselling of solid wastes to other industries in the area and separation of recyclable materials for potential recycling.

Water Consumption

- Meter water consumption;
- Properly maintain water networks;
- Give priority to low water consuming industries;
- Encourage the use of water saving devices and water conservation practices;
- Using treated wastewater as planned, for landscaping irrigation; and
- Regularly update fresh water demand projections and compare them with the Water Authority's supply capabilities.

6.3 Recommended Environmental Monitoring During Construction

Solid Waste Disposal

The Contractor must ensure that all solid wastes produced as a result of construction activities or any related activities are properly disposed of in the Aqaba Municipal Landfill. The Contractor must also ensure that all soil conditions are reinstated following construction.

Archaeological Resources

The Contractor should pay for an archaeologist to be on site during major earthworks and excavations to ensure that no artifacts are damaged or destroyed if encountered. The

Contractor should also ensure that clear guidelines are provided to the responsible on-site engineers in the event of encountering archaeological artifacts. The on-site engineer must stop activities at the site and inform the DoA. Procedures established by the DoA in accordance with law No. 21 1988 for the protection of antiquities in Jordan should be followed.

Flora, Fauna, and Habitats

The Contractor must ensure that no hunting activities are practiced in the vicinity of the site, and that indigenous species such as acacia trees (if removed) are replanted if possible.

6.4 Recommended Environmental Monitoring During Operation

Prior to operation, clear and comprehensive environmental monitoring guidelines should be developed. The recommendations provided in the discussion that follows should provide the basis for such environmental monitoring guidelines. Contingency plans should also be developed to guide actions to be taken in the event of accidents, spills and breaches of appropriated standards.

Wastewater

The Estate should monitor wastewater quality to ensure that its quality parameters conform to domestic wastewater quality standards and within the design parameters of the AMWWTP. The parameters to be monitored should be designed specifically according to each industry and should be clearly stated in the operations permit along with monitoring frequency and reporting requirements.

Air Emissions

Prior to start of operation, standards should be designed with maximum allowable limits for stack emissions if permitted. Jordanian standards for stack emissions are not to be applied since they are designated for heavy and not light industries, therefore stricter standards should be applied especially in light of the selected site's location.

The permitting procedures to be designed for the Estate should be clear and strict about admitting industries for establishment that may generate stack emissions exceeding standards that may affect the neighboring airport and the downwind town of Aqaba. A monitoring program for industries with possible air emissions should be designed and written down in their operational permits along with the frequency of monitoring and reporting requirements.

Occupational Health and Safety

The main issue of concern at Aqaba and in common among the industries within the Estate is the excessive heat expected during the summer months in areas not equipped with air conditioning devices. Indoor working environment temperatures should be monitored regularly and working hours adjusted according to JS 525/1987 (Annex D).

6.5 Recommendations for Environmental Operating and Permitting Procedures

As part of the Environmental Assessment (EA), an environmental mitigation and monitoring plan is designed for both construction and operation of the industrial estate. However, this EA is conducted only taking into consideration the potential industries that might be established in the proposed Aqaba International Industrial Estate based on the marketing studies carried out in the feasibility study.

A common practice and a very significant issue that came up in the scoping session is the design and implementation of specific permitting procedures for Aqaba Industrial Estate that the administration of the Estate would be responsible for implementing. The main purpose of permitting procedures from an environmental perspective would be to screen out potentially polluting industries and prevent their establishment at the proposed Estate. Such permitting procedures are usually drawn to assist investors in their application procedures and provide information to the permitting/licensing agencies to decide on the appropriateness of such industries to be established. The permitting process would also act as source of baseline data for assessments of industries.

An environmental permit form would provide industry-specific information, such as:

- Water Consumption
- Wastewater discharge and quality
- Air emissions from the industry
- Solid, liquid, and hazardous waste generation and discharge
- Energy requirements
- Types of fuels to be used and their storage specifications
- Noise levels generated
- Raw and intermediary materials used in the industrial processes (hazardous and non-hazardous materials)
- Storage of materials (and the measures to be taken in case of hazardous materials)
- Number of production lines, estimated output by product/year, details of production process
- Others (e.g. equipment and machinery to be used)

Such an application will then be screened by authorities to determine whether an EA or Environmental Review (ER) should be carried out for the establishment of such industry within the Aqaba QIZ. Certain industries might not require either an EA or ER. Environmental permits are usually issued based on the screening process and the findings of environmental assessment or reviews. Once issued, environmental permits might include certain conditions that investors have to meet.

In the event that an industry does not conform to any of the above items such as having wastewater quality above the applied standards, producing hazardous wastes, containing hazardous primary or intermediary materials, or producing air emissions, such industries should not then be allowed to get established within the Proposed Estate. The issue of air emissions quality should be highly emphasized, taking into consideration the proximity of the Estate to Aqaba Town.

This Environmental Assessment for Aqaba QIZ is conducted based on the potential industries mentioned earlier. These are light industries that have minimal environmental impact during operation, and mitigation measures are designed to address all foreseen impacts of these particular industries. However, any alterations to the composition of these industries might create synergetic impacts that are not studied here and this will warrant another environmental impact assessment study to be conducted for Aqaba Industrial Estate.

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7. List of Preparers

This Environmental Assessment was prepared by EnviroConsult Office with the following EA Team Members:

Name	Specialty
Ra'ed Daoud	Project Manager / EA Specialist
Adnan Budieri	Biologist / Ecologist
Sawsan Fakhiri	Archaeologist / Chief DoA Inspector at Aqaba
Fadia Al-Emam Al-Husseini	Environmental Management / EA Assistant
Helena Naber	Environmental Health / EA Assistant
Osama Abu-Rayyan	Natural Resources / EA Assistant

8. Annexes

Annex A: Scoping Participants

Institution	*Name*
Aqaba Civil Defense Authority	*1. Mahmoud Al-Mattar* *2. Omar Al-Tarawneh*
Aqaba International Airport	*3. Omar Manha* *4. Nadi Mahareeq* *5. Ahmad Said Elqaq* *6. Adnan Rawajdeh**
Aqaba Municipality / ARA	*7. Issam Jaradat*
Aqaba Police Department	*8. Moh'd Mikdadi* *9. Hmoud Al-Kharabsheh*
Aqaba Ports Corporation	*10. Eid Abu El-Eaz*
Aqaba Regional Authority (ARA)	*11. Sawsan Zuweiri*
Aqaba Regional Authority (GTZ)	*12. Bridgette Baumer*
Aqaba Regional Authority (ARA) / Global Environment Facility (GEF)	*13. Mazen Khalil* *14. Khalid Abu Aeish* *15. Samer Milkawi*
Aqaba Water Authority	*16. Imad Zreiqat* *17. Jamal Al-Rabati*
Community Development Group (CDG)	*18. Ramzi Qawar*
Central Electricity Generating Company / Aqaba	*19. Fawzi Al-Hakeem* *20. Bader Tashtoush*
Department of Antiquities (DoA)	*21. Sawsan Fakhiri*
Friends of the Earth Middle East (FoEME)	*22. Munqeth Mehyar*
Jordan Industrial Estate Corporation (JIEC)	*23. Hani Khatatbeh*
Jordan Royal Ecological Diving Society (JREDS)	*24. Nedal Al-Ouran*
Marine Science Station	*25. Moh'd Badran*
Montgomery Watson Arabtech Jardaneh (MWAJ)	*26. Frank Grant* *27. Fawzi Abu Niaaj*
Royal Society for Conservation of Nature (RSCN)	*28. Maher Qishawi*
Traffic Control Department	*29. Major Khaled Sabti*
Water Authority of Jordan	*30. Edward Qunqur*
General Corporation for Environment Protection (GCEP)	*31. Yassin Zo'ubi*
United States Agency for International Development (USAID)	*32. Abdullah Ahmad* *33. Amal Hijazi* *34. Eric Peterson* *35. Jamal Al-Jabiri*

Annex B: Requirements for Discharges of Industrial Effluents

Table B-1: Summary of Jordanian Regulations Governing Discharge of Industrial & Commercial Wastewater Into the Sanitary Sewer System

Parameter	Unit	Maximum Allowable Limit
PH	Su	5.5-9.5
BOD	Mg/L	800
COD	mg/L	2100
TSS	mg/L	1100
P	mg/L	50
FOG	mg/L	50
MBAS	mg/L	26
Phenol	mg/L	10
Cr*	mg/L	5
Cu*	mg/L	4.5
Zn*	mg/L	15
Sn	mg/L	10
Be	mg/L	5
Ni*	mg/L	4
Cd*	mg/L	1
As	mg/L	5
Ba	mg/L	10
Pb*	mg/L	0.6
Mn	mg/L	10
Ag*	mg/L	1
B	mg/L	5
Hg*	mg/L	0.5
Fe	mg/L	50
S (as H_2s)	mg/L	10
Temperature	c^o	65
Chlorinated solvents	mg/L	0

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** The total concentration of all the double-asterisked materials should not exceed 10mg/l

Table B-2: Jordanian Standard 202/1991 Requirements for Discharges of Industrial Effluents

Parameter	Maximum Allowable Limit, (mg/1)+			
	Disposal To		Groundwater Recharge	Reuse for irrigation **
	Wadis & Rivers	Sea		
BOD_5	50 (M)	-	50 (M)	-
COD	150 (M)	200	150 (M)	-
DO	1*	5*	1*	1*
TDS	3000 (1)	-	1500 (1)	2000 (2)
TSS	50	-	-	100 (3)
pH (SU)	6.5-9.0	5.5-9.0	6.5-9.0	6.5-8.4
COLOR (UNIT)	15	75	15	-
TC	-	4	-	-
FOG	5	10	Absent	5
PHENOL	0.002	1	0.002	0.002
MBAS	25	-	15	-
NO_3-N	12 (4)	-	12 (4)	30
NH_3	5	12	5	5
Total-N	-	125	-	50
PO_4-P	15	-	-	-
Cl-	500	-	500	350(3)
SO_4	500	-	500	400
F	1.5	-	1.5	-
HCO_3	-	-	-	500
Na	-	-	400	-
Mg	-	-	-	-
Ca	-	-	-	-
SAR	-	-	-	9
Al	5	-	0.3	5
As	0.05	0.1	0.05	0.1
B	1	-	1	1(5)
Cr	0.1	0.3	0.05	0.1
Cu	2	0.1	2	0.2
Fe	1	2	1	5
Mn	0.2	0.2	0.2	0.2
Ni	0.2	0.02	0.1	0.2
Pb	0.1	0.1	0.1	1
Se	0.02	0.02	0.05	0.02
Cd	0.01	0.07	0.02	0.01
Zn	15	-	15	15

Table B-2 Continued…

Parameter	Maximum Allowable Limit, (mg/1)+			
	Disposal To		Groundwater Recharge	Reuse for irrigation **
	Wadis & Rivers	Sea		
Sn	0.1	1	0.1	0.1
Hg	0.001	0.001	0.001	0.001
TCC MPN\100 ml		5000	-	-
TFCC MPN\100 ml	1000(6)	-	1000(6)	1000(6)
Nematodes	<1	-	-	<1

+ All units are in mg/1 except where noted.
* Minimum value.
** Depends upon, type and quantity of crops, irrigation methods, soil type , climate & groundwater in the area concerned.
- undetermined.
M = monthly average.

Notes:

1. TDS allowable limit is subject to the TDS concentration in the water supply and the water basin affected.
2. Allowable limits of wastewater reuse determine the degree of restriction (none, slight to moderate, or service).
3. Method of irrigation is determined by wastewater quality being used.
4. Nitrate concentrations allowed are determined by its concentrations in the affected water basin.
5. Could reach 3 mg/1.
6. Geometric mean.

Table B-3: Jordanian Standard 893/1995 Requirements for Treated Domestic Wastewater Disposal

Parameter	Cooked Vegetables	Fruit & Forestry Trees, Crops & Industrial Produce	Discharge to Streams, Wadis & Reservoirs	Ground-water Recharge	Fish Ponds (2)	Irrigation of Lawns and Parks	Irrigation of Fodder Crops (1)
BOD_5 (3)	150	150	50	50	-	50	250
COD	500	500	200	200	-	200	700
DO	> 2	> 2	> 2	> 2	> 5	> 2	> 1
TDS	2000	2000	2000	1500	2000	2000	2000
TSS	200	200	50	50	25	50	250
PH	6.0 - 9.0	6.0 - 9.0	6.0 – 9.0	6.0 - 9.0	6.0 - 9.0	6.0 - 9.0	6.0 - 9.0
Color (PCU) (4)	-	-	75	75	-	75	-
FOG	8	8	8	None	8	8	12
Phenol	0.002	0.002	0.002	0.002	0.001	0.002	0.002
MBAS	50	50	25	15	0.2	15	50
NO_3_- N	50	50	25	25	-	25	50
NH4+- N	-	-	15	15	0.5	50	-
Total - N	100	100	50	50	-	100	-
PO4 – P	-	-	15	15	-	15	-
Cl-	350	350	350	350	-	350	350
SO4 --	1000	1000	1000	1000	-	1000	1000
CO3--	6	6	6	6	-	6	6
HCO3-	520	520	520	520	-	520	520
Na+	230	230	230	230	-	230	230
Mg++	60	60	60	60	-	60	60
Ca++	400	400	400	400	-	400	400
SAR	9	9	9	9	-	12	9
Residual Cl_2 (5)	0.5	-	-	-	-	0.5	-
Al	5	5	5	1	-	5	5
As	0.1	0.1	0.05	0.05	0.05	0.1	0.1
Be	0.1	0.1	0.1	0.1	1.1	0.1	0.1
Cu	0.2	0.2	0.2	0.2	0.04	0.2	0.2
F	1	1	1	1	1.5	1	1
Fe	5	5	2	1	0.5	5	5
Li	2.5	5	1	1	-	3	5
Mn	0.2	0.2	0.2	0.2	1	0.2	0.2
Ni	0.2	0.2	0.2	0.2	0.4	0.2	0.2
Pb	5	5	0.1	0.1	0.15	0.1	5
Se	0.02	0.02	0.02	0.02	0.05	0.02	0.02
Cd	0.01	0.01	0.01	0.01	0.015	0.01	0.01
Zn	2	2	15	15	0.6	2	2
CN	0.1	0.1	0.1	0.1	0.005	0.1	0.1
Cr	0.1	0.1	0.05	0.05	0.1	0.1	0.1

Table B-3 Continued…

Parameter	Cooked Vegetables	Fruit & Forestry Trees, Crops & Industrial Produce	Discharge to Streams, Wadis & Reservoirs	Ground-water Recharge	Fish Ponds (2)	Irrigation of Lawns and Parks	Irrigation of Fodder Crops (1)
Hg	0.001	0.001	0.001	0.001	0.00005	0.001	0.001
V	0.1	0.1	0.1	0.1	-	0.1	0.1
Co	0.05	0.05	0.05	0.05	-	0.05	0.05
B	1	1	2	1	-	3	3
Mo	0.01	0.01	0.01	0.01	-	0.01	0.01
TFCC (MPN/ 100 ml) (6)	1000	-	1000	1000	10000	200	-
Pathogens	-	-	-	-	100000 (6)	None	-
Amoebae & Giardia (Cyst/L) (7)	<1	-	-	-	(3)	None	-
Nematodes (eggs/L) (8)	<1	-	<1	-	-	<1	<1

(-): Not Determined

(1): Values for trace elements and heavy metals are calculated based on the quantity of water of 1000m^3/1000m^2/year, these concentrations should be reduced in case more irrigation water is used.

(2): These figures depend on the type of fish, pH, TDS, and temperature.

(3): BOD in effluent from Waste Stabilization Ponds (Filtered), and from Mechanical Treatment Plant - (Not Filtered).

(4):PCU: Platinum Cobalt Unit.

(5): Contact period should not be less than 30 minutes

(6): The Most Probable Number per 100 ml.

(7):Cyst per Liter

(8):Eggs per Liter

(9): Salmonella per 100 ml

Annex C: Meteorological Data

Table C-1: Mean Monthly Temperature in C° at Aqaba Airport Station

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg.
1990	14.1	14.9	18.9	24.3	26.9	30.5	32.4	31.7	28.9	26.8	23.2	18.0	24.2
1991	14.4	16.5	20.8	25.3	27.8	31.1	31.5	31.4	29.1	26.7	21.0	14.3	24.2
1992	12.1	13.4	17.5	22.5	27.0	30.8	31.6	32.5	29.4	26.9	20.2	14.2	23.2
1993	12.7	13.9	18.4	23.8	27.2	31.4	32.1	33.2	30.0	27.7	20.9	17.4	24.1
1994	16.0	15.7	18.8	25.7	28.6	30.3	32.3	32.6	31.2	28.6	19.9	13.9	24.5
1995	14.5	16.2	19.9	22.4	27.9	32.1	32.5	32.5	30.9	25.6	19.0	15.6	24.1
1996	14.9	17.2	18.8	23.2	29.4	30.2	33.4	32.9	30.8	25.6	21.9	17.5	24.7

Table C-2: Mean Monthly Minimum Daily Temperature in C° at Aqaba Airport Station

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg.
1990	8.6	9	12.3	17.8	19.6	23	25.2	24.8	22.6	20.4	16.9	12.5	17.7
1991	8.8	10.2	14.7	18.5	20.9	23.7	24.8	24.7	22.9	20.7	14.9	8.5	17.8
1992	6.7	8.5	11.4	15.7	20	23.4	24.6	25.5	23.1	20	14.2	8.9	16.8
1993	7.3	8	12.1	16.6	20.6	23.8	24.7	25.9	23.3	21.3	14.9	12.1	17.6
1994	11.1	9.7	12.3	18.7	21.2	23	25.3	25.7	24.7	22.8	14.4	8.3	18.1
1995	8.4	10.4	13.7	15.4	20.7	24.5	25.7	25.8	24.5	19.6	13.1	9.9	17.6
1996	9.3	11.4	12.6	16.2	22.3	22.8	26.7	26.3	24	19.2	16.1	11.4	18.2

Table C-3: Total Monthly Precipitation in mm at Aqaba Airport Station

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1990	0	0	9	12.4	0	0	0	0	0	8.4	0	18.5	48.3
1991	4.5	0	30.6	0	0	0	0	0	0	0.2	0	3.6	38.9
1992	6.4	1.6	0	0	0	0	0	0	0	0	7	0.2	15.2
1993	0.4	1.8	0	0	0.2	0	0	0	0	9.3	0	35.2	46.9
1994	34.7	1	4.7	0.2	0	0	0	0	0.8	7.2	4.1	0	52.7
1995	0	6.4	0	4.7	0	0	0	0	0	0	0	0	11.1
1996	0.8	0.5	0.2	0	0	0	0	0	0	0	0.2	0.4	2.1

Table C-4: Solar Radiation in Global Jul/cm^2 at Aqaba Airport Station

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg.
1990	1315	1717	2148	2352	2862	2997	2914	2726	2382	1879	1456	1240	2166
1991	1345	1665	1939	2318	2655	2960	2818	2669	2298	1758	1477	1164	2089
1992	1259	N/A	N/A	2499	2606	2882	2869	2667	2301	1906	1421	1180	2159
1993	1245	1646	2226	2497	2442	2975	2917	2700	2375	1813	1438	1181	2121
1994	1116	1550	2149	2417	2826	3016	2926	2722	N/A	1739	1349	1277	2099
1995	1397	1618	2210	2479	2732	2972	2898	2727	2347	1928	1517	1303	2177
1996	1312	1541	1946	2553	2567	2973	2357	2322	2019	1760	1400	1222	1998

N/A: Not Available

Table C-5: Atmospheric Mean Monthly Pressure at Aqaba Airport Station

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg.
1990	1012	1008	1010	1004	1003	1001	998	999	1002	1005	1008	1009	1005
1991	1010	1009	1005	1004	1005	1000	999	999	1003	1005	1008	1010	1005
1992	1013	1011	1009	1005	1003	1001	1000	1000	1003	1006	1009	1011	1006
1993	1012	1011	1008	1005	1003	1001	999	1000	1002	1005	1008	1010	1005
1994	1009	1011	1007	1004	1003	1000	998	998	1002	1005	1007	1013	1005
1995	1012	1009	1007	1004	1003	1001	997	999	1003	1006	1009	1011	1005
1996	1008	1007	1005	1005	1002	1001	998	999	1002	1006	1008	1010	1004

Table C-6: Mean Monthly Relative Humidity in % at Aqaba Airport Station

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg.
1990	52.0	49.0	42.0	36.0	29.0	32.0	32.0	36.0	46.0	45.0	41.0	49.0	40.8
1991	53.0	45.0	45.0	34.0	36.0	34.0	41.0	43.0	50.0	46.0	50.0	53.0	44.2
1992	55.0	48.0	41.0	39.0	33.0	34.0	44.0	44.0	50.0	48.0	54.0	61.0	45.9
1993	62.0	57.0	50.0	37.0	35.0	30.0	34.0	36.0	45.0	44.0	52.0	63.0	45.4
1994	65.0	50.0	52.0	33.0	35.0	38.0	36.0	35.0	47.0	56.0	61.0	62.0	47.5
1995	63.0	63.0	55.0	48.0	43.0	37.0	36.0	41.0	47.0	54.0	45.0	55.0	48.9
1996	52.0	52.0	54.0	46.0	40.0	44.0	51.0	52.0	51.0	59.0	61.0	61.0	51.9

Table C-7: Mean Monthly Wind Speed in Knots at Aqaba Airport Station

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg.
1990	6.0	4.8	10.9	11.7	12.3	13.6	9.4	11.0	12.4	7.1	6.6	8.4	9.5
1991	4.4	5.8	6.8	8.5	9.5	7.3	8.7	9.4	10.9	7.5	6.1	3.5	7.4
1992	6.0	5.9	9.8	11.2	10.7	9.2	10.4	10.7	10.9	10.1	5.9	6.3	8.9
1993	9.7	7.7	11.0	10.2	12.2	12.4	9.9	8.9	12.6	9.3	8.6	7.6	10.0
1994	6.5	8.4	9.9	11.7	12.5	14.0	7.8	10.4	10.2	9.4	6.4	7.4	9.6
1995	7.9	6.9	9.9	9.3	12.4	15.2	10.0	12.1	10.3	8.8	9.8	9.7	10.2
1996	8.3	10.3	6.5	11.4	10.2	12.3	9.9	12.1	14.5	10.2	7.6	5.7	9.9

Table C-8: Prevailing Wind Direction in Degrees at Aqaba Airport Station

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg.
1992	335.0	285.0	256.0	336.0	345.0	344.0	340.0	245.0	4.0	360.0	360.0	343.0	296.1
1993	324.0	9.0	6.0	31.0	1.0	10.0	17.0	3.0	1.0	23.0	345.0	347.0	93.1
1994	5.0	340.0	341.0	11.0	359.0	350.0	349.0	337.0	331.0	331.0	326.0	332.0	284.3
1995	338.0	331.0	334.0	323.0	341.0	338.0	329.0	326.0	345.0	4.0	13.0	4.0	252.2
1996	1.0	349.0	344.0	344.0	345.0	342.0	346.0	342.0	351.0	355.0	6.0	6.0	260.9

Table C-9: Number of Days with Sandy/Dusty Winds at Aqaba Airport Station

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1990	3	1	11	3	0	7	0	0	0	1	3	2	31
1991	0	0	1	0	2	2	2	0	1	2	0	0	10
1992	2	4	6	2	3	1	0	0	0	0	0	1	19
1993	3	0	2	1	0	1	0	0	1	1	2	0	11
1994	2	1	0	0	0	0	0	0	0	0	0	0	3
1995	0	0	0	0	0	0	0	0	0	0	0	3	3

Annex D: JS 525/1987: Heat Levels Allowed to be Exposed to in Work Environment

The ***Labor Law (1996), Article 79-C,*** requires that temperatures in working environments are safe for workers (*health*) according to Jordanian Standards 525/1987 (JS 525/1987) as follows:

Table D-1: Wet Bulb Globe Temperature (WBGT)

Work Characteristics	Work Load		
	Light	Medium	Heavy
Working Continuously	30.0	26.7	25.0
75% Work, 25% Rest (every hour)	30.6	28.0	25.9
50% Work, 50% Rest (every evening)	31.4	29.4	27.9
25% Work, 75% Rest (every evening)	32.2	31.1	30.0

Table D-2: Work Load Estimations

a. Body Situation & Movement		Calorie/Minute	
Sitting		0.3	
Standing		0.3	
Walking		2 – 3	
Climbing Heights		0.8 / meter	
b. Work Characteristics		Calories Average Calorie / Minute	The Range Calorie / Minute
Manual Work	Light *	0.4	0.2 – 102
	Heavy ***	0.9	
Working with one hand	Light	1.0	0.7 – 2.5
	Heavy	1.7	
Working with both hands	Light	1.5	1.0 – 3.5
	Heavy	2.5	
Working with the whole body	Light	3.5	2.5 – 15
	Medium **	5.0	
	Heavy	7.0	
	Very Heavy	9.0	

* *Light Work: Until 200 Calorie/Hour*
** *Medium Work: Between 200 – 350 Calorie/Hour*
*** *Heavy Work: Between 350 – 500 Calorie/Hour*

Annex E: Flora and Fauna

Table E-1: Avifauna in Aqaba Region

	Common name	Scientific Name	Conservation Status	Status
1	Little Grebe	*Tachybaptus ruficollis*		WV
2	Black-necked Grebe	*Podiceps nigricollis*		WV
3	Squacco Heron	*Ardeola ralloides*		SV
4	Little Egret	*Egretta garzetta*		WV
5	Grey Heron	*Ardea cinerea*		SM
6	White Stork	*Ciconia ciconia*	Globally threatened 1	WV
7	Black Stork	*Ciconia nigra*	Globally threatened	SV
8	Spoonbill	*Platea leucordia*		PM
9	Teal	*Anas crecca*		R, WV
10	Mallard	*Anas platyrhynchos*	Endangered (JO)	WV
11	Pintail	*Anas acuta*		WV
12	Garganey	Anas querquedula		PM
13	Shoveler	*Anas clypeata*		WV, V
14	Marsh Harrier	*Circus aeruginosus*		R
15	Lesser Spotted Eagle	*Aquila pomarina*	Regionally threatened	PM
16	Steppe Eagle	*Aquila nipalensis*		AM
17	Kestrel	*Falco tinnunculus*		R
18	Saker Falcon	*Falco cherrug*	Regionally threatened 2	PM, WV
19	Moorhen	*Gallinula chloropus*		R, WV
20	Coot	*Fulica atra*	Endangered (JO)	R, WV
21	Black winged Stilt	*Himantopus himantopus*	Globally threatened	SV
22	Ringed Plover	*Charadrius hiaticula*		WV/ PM
23	Spur-winged Plover	*Hoplopterus spinosus*		R, SV
24	Little Stint	*Calidris minuta*	Globally threatened 1	WV
25	Common Snipe	*Gallinago gallinago*		WV
26	Curlew	*Numenius arquata*		WV/ PM
27	Spotted Redshank	*Tringa erythropus*		PM
28	Redshank	*Tringa totanus*		R, WV
29	Marsh Sandpiper	*Tringa stagnatilis*		PM
30	Green Sandpiper	*Tringa ochropus*		R, WV
31	Common Sandpiper	*Actitis hypoleucos*		PM
32	Ruff	*Philomachus pugnax*	Globally threatened	PM, WV
33	White-eyed Gull	*Larus leucophthalmus*	Globally threatened	NBr., SV (small nos.)
34	Black-headed Gull	*Larus ridibundus*		PM/AM

Table E-1 Continued…

	Common name	Scientific Name	Conservation Status	Status
35	Slender-billed Gull	*Larus genei*		SV, V
36	Common Tern	*Sterna hirundo*		SV, V
37	Whiskered Tern	*Chlidonias hybridus*		SV
38	White-winged Black Tern	*Chlidonias leucopterus*	Globally threatened	SM
39	Rock Dove	*Columba livia*		R
40	Collared Dove	*Streptopelia decaocto*		R
41	Palm Dove	*Streptopelia senegalensis*		R
42	Pallid Swift	*Apus pallidus*		SV
43	Pied kingfisher	*Ceryle rudis*		WV
44	Short-toed Lark	*Calandrella brachydactyla*		SV
45	Crag Martin	*Ptyonoprogne rupestris*		WV/ AM
46	Swallow	*Hirundo rustica*		SV
47	Red-throated Pipit	*Anthus cervinus*		AM
48	Yellow Wagtail	*Motacilla flava*		SV
49	White Wagtail	*Motacilla alba*		WV
50	Yellow-vented Bulbul	*Pycnonotus xanthopygos*	Common, restricted largely to the Middle East	R
51	Bluethroat	*Luscinia svecica*		WV
52	Whinchat	*Saxicola ruberta*		SV
53	Red-backed Shrike	*Lanius collurio*		SV
54	Graceful Warbler	*Prinia gracilis*	Common	R
55	Spotted Flycatcher	*Muscicapa striata*		SV
56	Spanish Sparrow	*Passer hispaniolensis*		R
57	House Sparrow	*Passer domesticus*	Common	R

1 1% or more of population crosses or stays during migration

2 Listed on the Bonn Convention, Appendix II

KEY:

WV: Winter Visitor AM: Autumn Migrant Br: Breeding
SM: Spring Migrant V: Vagrant R: Resident
SV: Summer Visitor PM: Passage Migrant NBr.: Non breeding

Table E-2: Threatened Avifauna Species in Aqaba Region

1- Globally threatened	
Black Stork	*Ciconia nigra*
Black winged Stilt	*Himantopus himantopus*
Ruff	*Philomachus pugnax*
White-winged Black Tern	*Chlidonias leucopterus*
White Stork	*Ciconia ciconia*
Little Stint	Calidris minuta
White-eyed Gull	*Larus leucophthalmus*
2- Regionally threatened	
Lesser Spotted Eagle	*Aquila pomarina*
Saker Falcon	*Falco cherrug*
3- Locally threatened	
Mallard	*Anas platyrhynchos*
Coot	*Fulica atra*

Table E-3: Reptile Species of Concern in Aqaba Region

Common Name	Scientific Name	Status
Spiny-Tailed Lizard (Dabb)	*Uromastyx aegytia microlipis*	E
Desert Monitor	*Varanus griseus*	E
Tortoise	*Testudo graeca*	E

E – Endangered
T – Threatened

Table E-4: Mammal Species of Concern in Aqaba Region

Common Name	Scientific Name	Status
Sand Cat	*Felis margarita*	T
Rock Hyrax	*Procavia Capensi*	T
Indian Crested Porcupine	*Hystrix indica*	E

T – Threatened
E – Endangered

Table E-5: List of Flora Species in Aqaba Region

Species	Family
Aaronsohnia factorovskyi	Compositae
Acacia raddiana	Leguminosae (Locally threatened)
Acacia tortilis	Leguminosae (Locally threatened)
Aerva javanica	Amaranthaceae
Aizoon canariensis	Aizoaceae
Anabasis setifera	Chenopodiaceae
Anthemis tinctoria	Compositae
Arnebia tinctoria	Boraginaceae
Asphodelus tenuifolius	Liliaceae
Asteriscus graveolens	Compositae
Asteriscus pygmaeus	Compositae
Astragalus sieberi	Leguminosae
Atriplex leucoclada	Chenopodiaceae
Bassia muricata	Chenopodiaceae
Blepharis ciliaris	Acanthaceae
Capparis cartilaginea	Capparaceae
Caralluma sinaica	Asclepiadaceae (IUCN Red List, R)
Cassia senna	Leguminosae
Centaurea ammocyanus	Compositae
Centaurea dumulosa	Compositae
Centaurea pallescens	Compositae
Centaurea sinaica	Compositae
Cistanche tubulosa	Orbanchaceae
Citrullus colocynthus	Cucurbitaceae
Cleome africana	Capparaceae
Cucumis propheratum	Cucurbitaceae
Erodium bryoniifolium	Geraniaceae
Euphorbia chamaepeplus	Euphorbiaceae
Fagonia mollis	Zygophyllaceae
Filago desertorum	Compositae
Gomphocarpus sinaicus	Asclepiadaceae
Gymnarrhena micrantha	Compositae
Halogeton alopecuroides	Chenopodiaceae
Hippocrepis unisiliquosa	Leguminosae
Hyoscyamus desertorum	Solonaceae
Iflago spicata	Compositae
Launaea capitata	Compositae
Leysera leseroides	Compositae

Table E-5 Continued…

Species	Family
Linaria haelava	Scrophulariaceae
Malva parviflora	Malvaceae
Mesembryanthemum nodiflorum	Aizoaceae
Morettia canescens	Cruciferae
Neurada procumbens	Neurodaceae
Notoceras bicorne	Cruciferae
Ochradenus baccatus	Resedaceae
Opophytum forskahlii	Aizoaceae
Papaver polytricum	Papaveraceae
Paronychia sinaica	Caryophyllaceae
Pergularia tomentosa	Asclepiadaceae
Plantago ciliata	Plantaginaceae
Plantago cylindrica	Plantaginaceae
Pteranthus dichotomus	Caryophyllaceae
Pulicaria incisa	Compositae
Retama raetam	Leguminosae
Salvia lanigra	Labiatae
Scorzonera tortuosissima	Compositae
Scrophularia deserti	Scrophulariaceae
Senecio flavus	Compositae
Silene colorata	Caryophyllaceae
Stipa capensis	Gramineae
Stipagrostis raddiana	Gramineae
Traganum nudatum	Chenopodiaceae
Trichodesma africana	Boraginaceae
Urginea undulata	Liliaceae
Zilla spinosa	Cruciferae

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